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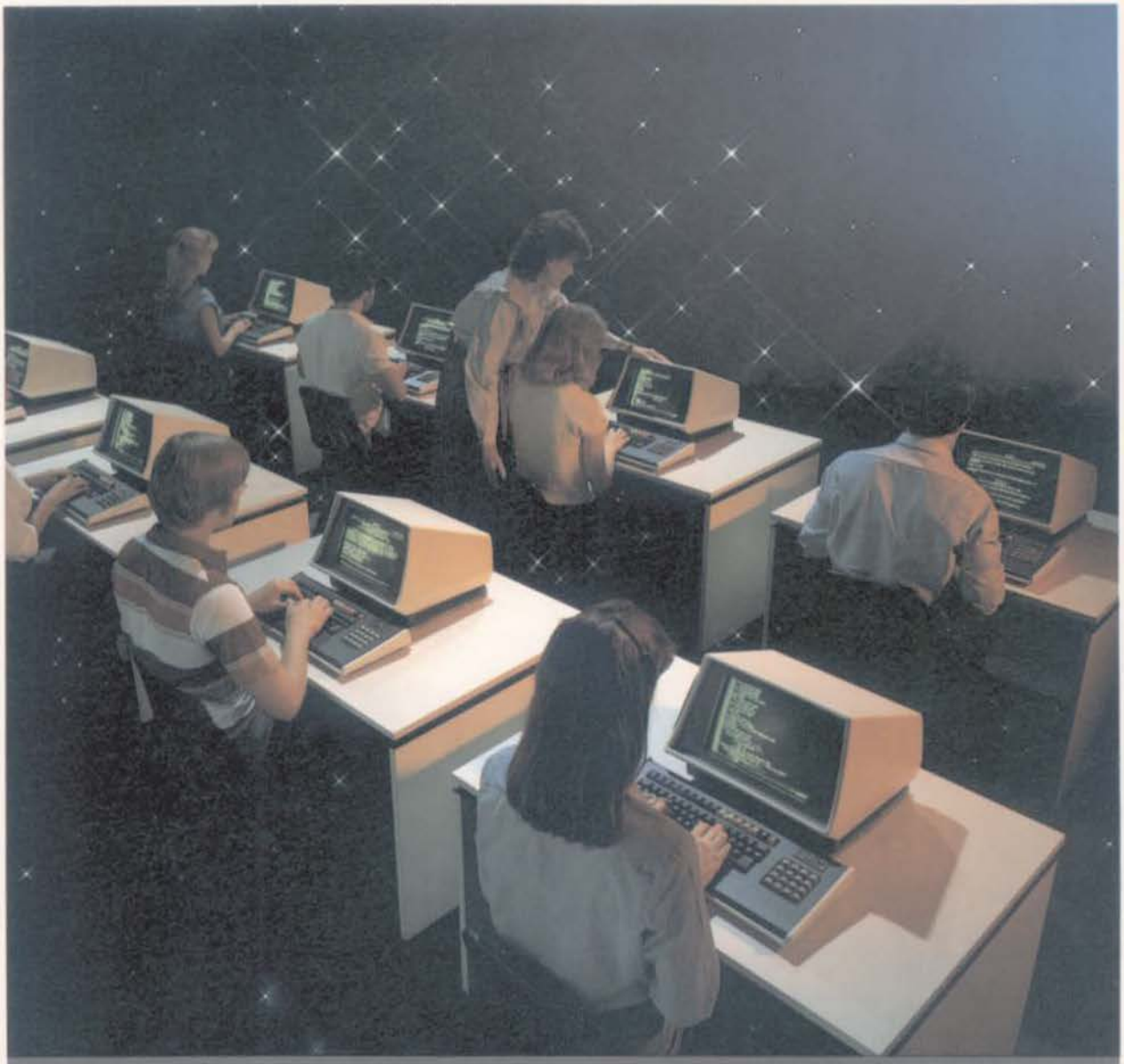

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FOREIGN

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Items Submitted for Publication

Articles submitted for publication should be accompanied by the authors **full name, address, date and telephone number.** It is preferred that articles be submitted on either 5 or 8 inch diskette in TSC Editor format or STYLO format. All diskettes will be returned.

The following TSC Text Processor commands **ONLY** should be used (due to our proportional processor): .sp space, .pp paragraph, .fi fill and .nf no fill. Also please do not format within the text with multiple spaces. The rest we will enter at time of editing.

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By: Ronald W. Anderson
As published in 68 MICRO JOURNAL™

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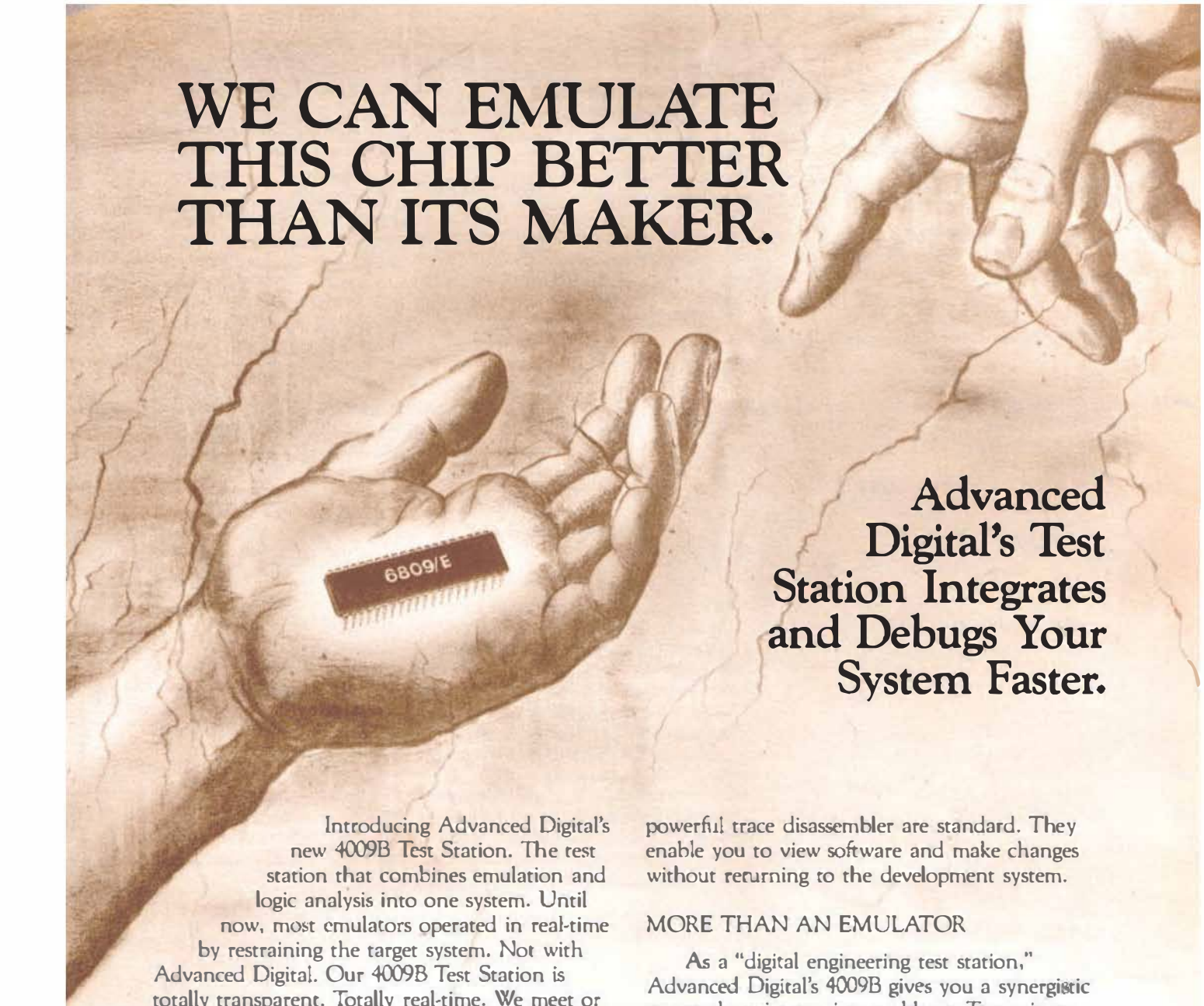

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Flex User Notes

Ronald W. Anderson
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Ann Arbor, MI 48105

STANDARDS

I've just received a set of proposed standards for FLEX software from Alan Fowler. He wrote an a letter that appeared in the September (83) issue regarding the portability (or lack of it) of FLEX software, and how it could be made easier to adapt such software if there were certain standards available to which suppliers would adhere. I find myself in agreement with Alan, most particularly in the area of printer and terminal interfaces. For some reason, there is no standard set of control characters for terminals. While some terminals can do just about anything when given a two character sequence of ESC and a character, some require strings of 5 or 6 characters to do the same thing.

Such problems don't exist if we limit ourselves forever to line editors and non screen oriented software. Most of the "good" software is user interactive, and takes advantage of all of the features of the smart terminal. For example, Reverse Video, Half Intensity, Erase to end of line, Insert line, and Delete line. By taking advantage of these features, a screen menu or a screen oriented editor may be made to run MUCH faster. Our 68XX market, however, is small enough already so that no supplier in his right mind would want to limit his market to only those who have CT-82(XX) terminals, or Televideo, or Soroc... In order to be usable on any terminal, a piece of software needs to be user configurable. The control strings need to be long enough so that even the terminal that requires 4 or 5 characters may be used.

To make things harder, some terminals, including the one on which I am typing at this moment, simply don't have some of these features. I can get along without reverse video and half intensity, by simply outputting nulls to my terminal so that no damage is done. This terminal, however, doesn't have protected fields, so it is not possible to do a "Clear non-protected to spaces" for example. It also cannot do an "Insert line" or a "delete line". On terminals with this feature, it is only necessary to issue an instruction to the terminal to delete a line, or insert one, for example. Without such features, you must rewrite the screen from the cursor to the bottom to duplicate such an action. If a terminal doesn't have Erase to end of line, it is necessary to output spaces from present cursor location to end of line.

I will praise any supplier who takes advantage of these features of the smart terminals, but I would hope that he would make his software smart enough to recognize the fact that the user had configured the control string to all nulls, and on that signal, jump to a routine to "do it the dumb way". For the user, there is the advantage that some pretty fancy software will work on even the dumbest of terminals. For the supplier, there is the advantage that he is not "ruling out" any SS-50 bus system owner from using his software. If a user has a smart terminal, he will get the best possible operation. If he has a dumb one, he will understand that the limitation is in his equipment and not the software. I run my Dumb Terminal (you guessed correctly by now that it is an ADM-3A) at 19.2K baud, and it does reasonably well with software that rewrites the screen every time something fancy is done.

Incidentally, though I have used a number of other terminals, and I must say that I like some of the nice displays that may be done with reverse video and half intensity, I have never found a keyboard that surpasses my old ADM-3. Many of the newer ones could be described as "skritchy" (the sound they make). Also, the newer ones seem to "make" about the time they are touched. The old ADM keys don't make until they are about 80% depressed. Perhaps it is just a matter of "what I am accustomed to", but I really think the quality of keyboards has gone down considerably in the past few years. I won't belabor the point further.

Spelling Again

Hey, Don Williams! At the end of my September column you inserted a note that some FLEX versions "encompass enCHANTments" coded by SWTP programmers. Of course you meant "enhancements" but a reader wrote to say that he "always wondered why 68xx code always seemed to have such magical qualities." If you are going to add to my efforts, you could at least identify your additions by using "(Ed.)" so I wouldn't get the blame!! (And you've been bugging me to use a spelling checker). Seriously, the additions and clarifications are appreciated.

The Other Operating System

Right! I'm going to admit it. FLEX is not the ONLY operating system for our SS-50 (and TRS Color) computers. Right now, I am getting the pieces together to be able to run OS-9. Now I know that may sound like heresy coming from the author of "FLEX User Notes". Why then, am I going to explore OS-9? There are a couple of reasons. First is the chance that I might miss some good software that is available only in OS-9 version. Second, I think there is a place for an operating system that is more advanced than FLEX but doesn't require all the hardware required by UNIFLEX. That is, something sort of "in between". My first impression is that OS-9 might fit that slot, and perhaps be more appropriate for the hobbyist than UNIFLEX. I could go on with further first impressions, having finally gotten myself to read through an OS-9 manual, but I will reserve further comments for AFTER I have had a chance to run some things on my system for a while.

For now, just let me say that there are applications where one is more appropriate than the other. After I've sorted out some impressions I will report here. As my regular readers know, this column has sort of drifted into the area of compilers and software evaluations, though I try to keep a few good applications coming from month to month. I've never been heavily into describing or discussing the inner workings of FLEX, and I don't intend to get into that area of OS-9 (which is being covered very nicely by Peter Dibble in his column). Perhaps eventually, I'll have to rename this column to something like 68XX User Notes!

COMPILER - ASSEMBLER DEBATE

Last November's '68' Micro Journal contained some thoughts from me concerning the relative merits of Compiled languages and Assembler code. I mentioned letting Dan Farnsworth respond to it, and promptly forgot to send him a copy so he could respond and we could continue the discussion on a more timely basis. Dan has responded to my thoughts in that column, and I will quote his thoughts below.

"I would like to divide program creation into two functions. Writing the program and Coding the program. The Writing phase will take up most of the time and should be done in English. You should use diagrams, charts and any other methods for organizing your thoughts in a logical manner. When the Writing phase is completed you can now Code the program into the computer using any language that you have, in a relatively short time. It is my contention that Assembly language will run faster, take up less memory space, is more powerful, and easier to document than any of the High Level languages available.

High Level Languages contain a collection of subroutines which do the actual work. These subroutines are organized by the Syntax or instruction set of the HLL. I freely admit that I cheat when using the Assembler. Over the years I have collected 350 subroutines and burned them into 3K of ROM at the high end of memory. I also have about 50 pointers that are equated to the lower half of page 0. Now by LIB(rary)ing the two equate files I have locked my new program to a very powerful runtime package. It is easy to Code the program using the Assembler to setup and run the subroutines.

The modern Assemblers which are available will catch 90% of the errors. It only takes a minute or two to run the Assembler and I usually do this every 30 minutes. As each Module is entered I get it to run and Debug it before continuing. The use of Pointers in Page 0 for temporary storage and work space, makes debugging much easier than using the stack. When a program bombs, A listing of page 0 will usually tell you within 5 lines of where the program took off. The use of subroutines that have previously been debugged is also a great help in getting programs to run properly with a minimum of hassle."

Dan's letter continues indicating that he will send me some further thoughts getting into more detail, including some examples of code, etc. He also has invited me to write my "rebuttal" of the above.

Dan, it seems to me that we agree on more points than we disagree. I will make a few points, though. First I agree in principle about the separation of the writing of the program and the coding. When I test a new compiler, I generally try to separate out the "writing" errors from the "coding" errors, by translating a program written in another similar language to the new one. You might say that I am just "re-coding" that program. When I do that and the program doesn't run, I can pretty well assume that some statement in the new language didn't do what I expected it to do. In other words, I made a coding error. (Sometimes I find that the new compiler doesn't do what its author expected, and indicated that it would do in the manual).

Perhaps much of what I do is repetitive so that I pretty well understand the "Writing" part of the programming, and I can proceed to the coding. Dan, I think if you were to work in Pascal or PL/9 for a while you would begin to see a GREAT similarity between your program and the English writing of the program you mention in the first paragraph of your discussion. I've tried several times to start writing an article about programming in general (or rather in English), to discuss WHILE DO loops, and REPEAT UNTIL loops, etc. Any discussion of such programming concepts leads immediately to English statements that look so much like Pascal, that I might as well use Pascal for the discussion. I might add that PL/9 is only a tiny bit less "English like" than Pascal, and "C" just a little more abstract, once you understand the syntax.

Let's look at efficiency for a few moments. Suppose, in an assembler program you want to create a variable and then later in the program you want to set it to the value (decimal) 100. In assembler you would create the variable (I'll use a single byte variable) by the statement VARIABLE RMB 1. You would set it equal to 100 with two statements, LDA #100 - STA VARIABLE. In PL/9 you would create the variable with BYTE VARIABLE; and set it equal to 100 with VARIABLE = 100;. If you do just that in PL/9 you will find out that PL/9 generates code just as efficient as that I used in the assembler version above. (Actually, byte variables are handled in PL/9 by the B accumulator, so that the generated instructions would be LDB #100 - STB OFFSET,Y. Just as in the case of the assembler above, if the number of variables is small, they are all accessed with a two byte code. An assembler programmer would probably use direct page for a small number of variables, and STA direct is a two byte code as is STB indexed with a small offset. I agree that this is a simple example, but many of the compiled languages now output code that when disassembled looks "just like someone did it in assembler" a great deal of the time. Although I've use PL/9 in this example, I have more than one of each of Pascal and C compilers that generate code just as efficiently.

Another point that you made is that you had written a number of subroutines that you use in writing programs in assembler. In effect, you have written your own compiler in "secret code" that no one else can understand as easily as you. Using a standard language results in a program that may be understood by someone else quite easily. I realize that there are situations in which no one else will ever have to understand a program, and that is a "so what" situation. However, as programs become larger and larger, and reach the point where more than one person has to work on them, or when they must be maintained for customers over a long period of time, so that there is no guarantee that the original author will still be an employee of the company, (or for that matter, might be ill or even die), the use of a higher level language makes much more sense.

Now having said that, let me indicate an exception. A company recently came to me for some consulting in the area of programming. I started trying to convert them to a HLL immediately. Later I found out that the product (or at least one of them) is a high volume item (sales in the thousands per year) and the program is 2 or 3K of assembler code. Not only do I think Assembler is ideal for this sort of application, I agree that this company should still be using the 6800 rather than the 6809 because of the cost differential. The cost of writing the program in assembler might be as much as a dollar per unit. So what? If the smaller code can save one $4.00 EPROM the savings are considerable.

One area in which we agree completely, is that programs should be written in small modules, and the modules tested one at a time. In a high level language, each module is a Procedure or Function. You can write a simple test program for each one, or continue to add new procedures and expand the " ain program" which becomes the test program for all the procedures. When you are done adding procedures, your program will be done. Of course, in Assembler programming, the modules are subroutines, and you can go through exactly the same process to get your progra running. A common but very costly practice of novice programmers is to write an entire program and then start debugging it. (I know, I used to do it that way myself.) Assembler programmers tend not to make some particular module a subroutine unless it is used more than once in the program. More experienced programmers in both Assembler and HLL's tend to write shorter modules and separate them out of the main program even though they are only used once, since this practice results in shorter modules to debug, and greatly facilitates debugging.

Many BASIC and Assembler pr grammers are puzzled by the concept of "local variables" in the structured languages. The use of local variables in a procedure of function, greatly reduces the chance of accidentally "clobbering" the value in a variable that was not intended to be modified by the procedure. Good programmers tend to maximize the use of local variables (these only exist while the procedure or subroutine is running). They tend to pass the procedure the information that it needs to calculate its result, and let the procedure return its result in a very controlled manner rather than allowing all parts of the program to access all the variables. There is not enough space here to go into this aspect of programming as much as I would like at this time, but it can be the topic for discussion in a future column. Of course a good Assembler programmer can use the same techniques to minimize interaction of modules, but most do not.

Lastly, I would like to expand on Dan's comment "You should use diagrams, charts, and any other methods for organizing your thoughts in a logical manner." I don't believe in flow charts in general. I've found that the only way to get them to represent a program accurately, is to prepare them after the program is debugged. However, they are VERY useful to straighten out particularly complex logic in a section of code where a number of decision points exist, and the code to be executed in each case is not quite as straightforward as in a "case statement". In such cases, I've resorted to a flowchart with excellent results. By all means use whatever method you know that can help you organize your program.

OS9 USER NOTES

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More About Computers at School

I had my first chance to look through a microscope when I was very young. My sister was deeply engrossed in the microscopic world so I, being a typical younger brother, hung around and made a pest of myself until she showed me what she was working on. I couldn't see anything but a blur which sometimes faded out altogether. I didn't see much point in looking at a blur. As years went by I was given my own microscope, but chemistry sets, and my own experiments, were much more interesting. I still had trouble getting interested in blurs.

In ninth grade I encountered a real microscope for the first time. It was a fine old instrument. The teacher treated it with great respect, and insisted that we do the same. When I first used it I got a surprise that stays with me to this day. It was nothing like the microscopes I had used before, focusing it with the fine adjustment knob was no problem, and when something was in focus, even a single cell or a bacterium, it was very clear. I could have happily spent weeks peering through the eyepiece at everything I could fit on the stage. Eventually the class moved on to other things, but I had a new appreciation for the world of the very small.

It is unfair to blame my parents for not getting me a high quality microscope when I was eight, but it bothers me to think of what I missed. I was fascinated by what the microscope revealed when I was a teenager. The effect would have been even stronger if I had been younger.

My experience with the microscope is what makes me keep complaining about the tendency of schools to use the lowest quality hardware and software they can find.

The younger the students, the lower the quality. The argument is that sophisticated hardware and software isn't needed for any but the most advanced students. This is a serious error. With computers "foolproof" means either trivial, or very sophisticated. It requires good hardware, and excellent software to deal satisfactorily with the worst a child can do. The kids at most schools are getting the same kind of experience with computers I got with my early microscope ... only a blurry image of what it should be.

The section of a column I wrote a few months ago about computers for schools has drawn more comment than any other column I have written, maybe more than all of them put together. Some people wrote to agree, others disagreed. I was glad to hear from those who agreed with me, but I was most interested in the letters from people who took issue with one or more of my points. Two of my points drew particularly heavy criticism. I calculated the price of an imaginary (but realistic) single-user computer. Several people thought an adequate computer could be purchased for less than I suggested. I also spent some time wishing schools would stop using Basic. It didn't surprise me that several readers felt Basic was a fine language.

The little story about the microscope was intended to address the question: "why bother to provide decent computers at school?" Students should be given a chance to use a computer that they don't have to struggle with, and a language that encourages clear thinking. Kids don't know enough to complain about Basic on the cheapest computer that can be found. I do, so I am complaining for them.

.....

There were about five more paragraphs here about Basic, and the evils of skimping on computers for children, but while re-reading the column I decided that I sounded a bit shrill. Please forgive the abrupt transition, but the smooth conclusion of this argument has been pruned with a quick block-delete.

Pipes

One of the most useful features of OS-9 (and UNIX) is the pipe. Pipes by themselves aren't good for much, but if you build a good set of "software tools," pipes make many tasks surprisingly easy.

A pipe is a special device which forms a connection between two programs such that the output from one is directed into the input of the other. The shell is a major user of pipes. You can ask the shell to connect the standard output of one program to the standard input of another by putting an exclamation point "!" between the commands. The "!" separates commands like the ";" and "&" do, but it also redirects the output of the command before it into the input of the command after it. You could get the same effect by using intermediate files (Have the first command save its output into a disk file. When the first command ends, run the second command with its input coming from the file the first command wrote.), but intermediate files are neither as fast nor as easy to use as pipes.

When you first start using OS-9, pipes won't be of much use to you. For one thing they are a bit confusing, but, more important, the standard OS-9 utilities don't include many filters.

A filter is a program which reads from the standard input file and writes to the standard o tput file until end of file on standard input. They can be used without pipes, but, in combination with pipes, a good toolbox of filters can be among the most useful facilities available under OS-9.

The most elementary filter would simply copy bytes from standard input to standard output. More advanced filters change data on its way through. Some common filters sort the data, break it into words, remove duplicate lines, count bytes, words, and lines, and translate upper case letters to lower case.

It is relatively easy to write special filters to solve problems one at a time. The trick is to write filters which, in combination with others, can do lots of useful things. I have a filter which I call "words" (available from the OS-9 Users Group, but too long for this column) which breaks the input up into one word per line. I wrote another program which counts the number of <CR>s in the input and writes that number out when the end of the input is reached. I can hook those two programs together with a pipe to form a command line that counts the words in a file:

OS9: words <column10 ! linect

That command line feeds column10 into words which slices it up, one word per line. The output of words is fed into the standard input of linect which responds by giving me the number of lines in its input -- the number of words in column10. I can use linect by itself to find the number of lines in a file.

I have written other filters called sort and uniq. Sort sorts the standard input into the output. Uniq removes duplicate lines; for example:

```
Line One
Junk Line
Junk Line
Junk Line
Another line
```

would come out of Uniq

```
Line One
Junk Line
Another line
```

The command line:

OS9: words <column10 ! sort ! uniq

would break column10 into words, sort the list, remove duplicate lines, and give me a sorted list of the words I used in that column.

Since I have written a number of programs in assembler and Basic09 for this column, I thought I might include a few filters written in Pascal this month. Unfortunately old releases of OS-9 had a flaw in PIPEMAN which prevented it from working with Pascal programs. Pascal rewinds its standard input file when it starts. PIPEMAN wouldn't put up with a rewind with the upshot that filters written in Pascal couldn't even get started. The easiest language I know for writing filters is C, but since C isn't as widely used as assembler and Basic09, I'll include two filters, BWord in Basic09, and CharCt in assembler.

Both BWord and LineCt are crude programs. They are nowhere near as efficient as they can be. In particular, reading one character at a time is intensely bad practice under OS-9. Both of these programs could be generalized by using command parameters more extensively.

CharCt counts the number of occurrences of the first character in the command line parameter area in the standard input file. It could be generalized to look for character strings, or regular expressions. It might also be improved by using more than three bytes for the counter.

The shell always places at least a carriage return in the parameter area passed to a program it starts (FORKs). CharCt relies on this to give it an easy way to default to counting carriage returns in its input. If you want to count some other character use it as a parameter on the command line:

OS9: charct . <testfile

would count periods in testfile.

OS9: charct <testfile

would count carriage returns in testfile.

BWord splits the input file into lines, one word per line. A word is defined as a string of characters between spaces, tabs, or carriage returns. It would be more generally useful if it would define a word as a string of characters delimited by any given set of characters. One use of this that comes to mind is to divide a file into sentences by breaking it at each period.

BWords should be entered with Basic09, and packed. If you have RUNB you can run words with a command line like:

OS9: words <testfile

which will divide the text in testfile into words. If you don't have RUNB you might need to use a somewhat longer command line:

OS9: basic09 words <testfile

It is easy to spend a great deal of effort writing filters you will never use. What is needed is a set of general purpose tools. There are several sources for good ideas for filters. Books about UNIX often give descriptions of filters which are commonly used under UNIX. In general, if a concept is useful for UNIX it will also be for OS-9. The standard programming book, Software Tools, by Kernighan and Plauger, is an especially good source for ideas and algorithms.

A More Advanced Approach to Pipes

The Shell uses pipes to connect strings of its children together. Any program that has access to OS-9 system calls can use the same trick the shell uses to make the standard output of one of its children feed directly into the standard input of another, but it is simpler to use pipes as a connection between a process and its parent. If you need a formatted list of processes (the information given by the procs command) you can either mess with the process descriptors yourself, or use a pipe to intercept the output from procs.

If your algorithm can be divided into several sections that communicate in only one direction (Say, one section collects information, the second sorts it, and the third formats a report.), the job can easily be done by three separate processes dispatched from the command line with the shell managing the pipes. If the

steps aren't fixed (Perhaps you either report or update a file depending on the date.), it might be easier to deal with the pipes yourself. This type of thing requires pipes to be defined for each new process's standard input path.

Using a pipe as the standard output path from a child process is useful for more than intercepting the output from system utilities. The first experiments to try with this mechanism are with system utilities, but the most interesting applications are with processes designed especially for this use. An example might be a program which uses a process attached via a pipe to get data from a remote computer. The process at the end of the pipe would dial the remote computer up, go through the logon formalities, and deal with any communication protocols. The main process would just read distilled information from the pipe.

All three standard paths can be used for pipes. I haven't thought of a use for all three paths, but a combination of input and output paths is useful. The child process is given work to do through its standard input path and returns the results of its work through its standard, or error, output path. The parent process gives the child work through one pipe and at an appropriate time (maybe much later) gets the results by reading from a different pipe.

A FORKed process inherits the three standard paths of its parent. If it were OK to give up after setting up pipes, the way to set them up would be to close the standard files, and create three pipes, one each for path one, two and three. The instructions to open a pipe in the standard input path would be:

```
Pipe fcs "/PIPE"
lda #0 std in
OS9 I$CLOSE
leax Pipe,PCR
lda #UPDATE.
OS9 I$OPEN
```

New paths always take the lowest available path number so the pipe would fall into path zero. A process forked from this process would inherit its standard paths including the pipe in path zero. The new process would treat its path 0 as a normal standard input path. Characters written into the pipe by the parent would be read by the child.

If a pipe is opened with no process FORKed to use it, the pipe will act like a queue. A process can write a limited number of bytes into the pipe and read them out again in the same order they were written. If there isn't room in the queue for the data from a write to be stored the process doing the write will be put to sleep until there is space to complete the write. If the process that reads from the pipe is the same one that is sleeping until the queue empties a little there is a deadlock. A deadlock can only be avoided, or broken by some outside agency ... the human at the terminal for instance. Because of this deadlock problem, and the small size of the queue in the pipe, the idea of using a pipe as a queue is only a novelty.

The example of communications via pipes that I have invented is a Basic09 program that prompts for pairs of coordinates, and passes the pairs to a C program which "rasterizes" the lines between the points defined by the coordinates. The Basic09 program passes as many pairs as it likes to the C program, then closes the path it has been writing the data to. When the parent closes his end of the pipe the child will get an end-of-file. The C program sends the rasterized data back through its standard output path. This data consists of a string of zeros and ones indicating where dots should be placed on each horizontal line in order to draw the vectors received as input.

Rasterizing vector graphics information is a particularly good application for a separate process. In a Level Two system each process can use an entire address space of almost 64K. The size and resolution of the graph that is produced depends on the amount of memory available for the bit map of the graph. I have a version of rast that uses 46K for its bit map and can generate an 8"X8" graph on my Okidata at 72 dots per inch. I am not very experienced with graphics; there is probably a much better way to rasterize data than what I used. My program seems too complicated for such a simple task, but it works.

It is particularly important to keep track of interactions between two processes communicating via pipes. If the processes ever get into a situation where both are waiting for input from a pipe leading to the other process, they will be stuck until you free them by killing one of the processes.

The important part of this system of programs is an assembly language subroutine for the Basic09 program. The subroutine is descended from the StrfTask subroutine I published months ago, but has been enhanced to open pipes to the new process. The I$DUP call is used to preserve the standard input and output files of the Basic09 program while paths zero and one are turned into paths then back into whatever they were before.

Installation

This system of programs is written in three separate languages. If you don't have C it should be fairly easy to translate rast into Basic09, but if you rewrite rast in Basic09 be certain that you don't try to fork it directly. Basic09 should be the program you fork; rast should be the parameter. If you want to keep the old StrtTask around, rename either it or the new one. Grapher should be typed into Basic09 and saved. Particularly if you are using Level One, you should pack Grapher and use RunB to save memo y. In Summary:

```
Enter StrtTask and rast.c using an editor
Assemble StrtTask
Compile rast.c
Enter Grapher using Basic09
Save the source
If you intend to run Grapher from the command line
   add the line:  BYE to the end of Grapher
Pack Grapher
Run Grapher
It will load StrtTask and rast from the execution
   directory
```

Operation and Modification

Grapher will prompt for pairs of coordinates. After each pair is entered it will ask you to verify that you want to plot that line. Be careful with this. There is no validation in any part of this system. There is no reason it shouldn't be there either. Please add enough error checking to make you comfortable if you intend to do more than play with this program a little. If you try to draw a line way off into the wild blue yonder your computer will give it a good try, mashing everything in its way. After you enter the last pair of coordinates respond to the (y,n,d) prompt with D. The D response sends the last pair to rast and charts the response from rast on the screen. I like to draw conservative patterns like the one given by:

```
0 0 79 23
0 23 79 0
0 0 0 23
0 0 79 0
0 11 79 11
39 0 39 23
```

Rast is set up to rasterize a 80 by 24 graph. That is the size of a standard terminal, but if you want to deal with larger or smaller graphs, change VDIMENSION to the number of vertical dots in the graph, and HDIMENSION to the number of horizontal dots.

Pipes are a powerful tool for interprocess communications. They can be used with good effect to solve almost any interprocess communication problem if the connection can be made. The worst problem with pipes is that they can only be used between processes that are very closely related (between siblings, or parent/child). There is also a performance problem under Level Two; not only is there the cost of a system request per transfer, but OS-9 has to move the characters from one address space to another -- taking a surprising length of time. If you feel ambitious you will find that it is possible to make a major performance improvement to rast by using a compression algorithm on its output.

Welcome COCO

I have been reading messages in the COCO special interest group on Compuserve. It sounds like Microware put a real version of OS-9 on that little machine. I am seriously impressed with the reality of a very inexpensive computer with a UNIX-like, multitasking, even -- if I may stretch a point -- multi-user operating system. There may be a number of interesting ways to integrate COCOs with each other and with larger OS-9 systems to get a bargain version of advanced distributed computing. It may not be too much to hope for that Tandy will find a way to put OS-9 Level Two on some descendant of the COCO. There is some chance that I will be able to take the viewpoint of a COCO user in this column in the future. I haven't made up my mind yet, but I need a Level One system, and the Color Computer may be the way to get one. I would appreciate advice.

The Users Group

The executive committee of the OS-9 Users Group has met twice since the annual meeting (I am writing this in November). We have struggled with various issues and defined assorted policies, mostly rather dull. Very likely by the time this column is printed the members will have received a newsletter, and everyone will have seen information in this and other magazines. Right now our software library is ready to go. I know it has good stuff in it; several programs of mine are part of the collection. Our plan is to give a standard selection of software from the library to the existing membership and to each new member. The other programs in the library will be available for small amounts of money, or software contributions. The address of the Users Group is:

OS-9 Users Group
PO Box 8027
Des Moines, Iowa 50301

```
PROCEDURE bword
0000      (* ------------------------------------------------*)
0036      (* Filter to divide input into words. One word per  *)
008C      (* line.                                           *)
00A2      (* ------------------------------------------------*)
00D8      DIM chr:BYTE
00DF      DIM inword:BOOLEAN
00E6      DIM StdOut,StdIn,StdErr:INTEGER
00F5      ON ERROR GOTO 100
00FB      StdIn=0
0102      StdOut=1
0109      StdErr=2
0110      inword=FALSE
0116      LOOP
0118        GET #StdIn,chr
0122        IF inword THEN
012B          IF chr=ASC(' ') OR chr=9 OR chr=13 THEN
0147            inword=FALSE
0140            WRITE #StdOut
0153          ELSE
0157            PRINT #StdOut,CHR$(chr);
0163          ENDIF
0165        ELSE
0169          IF chr=ASC(' ') OR chr=9 OR chr=13 THEN
0185          ELSE
0189            inword=TRUE
018F            PRINT #StdOut,CHR$(chr);
0198          ENDIF
0190        ENDIF
019F      ENDLOOP
01A3      BYE
01A5 100  REM end of file handler
01BE      DIM errnum:INTEGER
01C5      errnum=ERR
01C6      IF errnum=211 THEN
01D7        BYE
01D9      ELSE
01DD        ON ERROR
01E0        PRINT #StdErr,"Error Number: ";errnum
01FB        BYE
01FD      ENDIF
```

```
00001                         NAM   CharCt
00002                         TTL   Count a occurances of a specified character
00003       *-------------------------------------------------*
00004       *   CharCt              Written  1 November 83    *
00005       *                  Last Modified  5 November 83   *
00006       *   A filter to count occurances of any specified *
00007       *   character in the standard input.  If no       *
00008       *   character is specified, default to counting   *
00009       *   carriage returns.                             *
00010       *-------------------------------------------------*
00011                         IFP1
00013                         ENDC
00014  0011           Type    set   Prgrm+Objct
00015  0081           Revs    set   ReEnt+1
00016  0000 87CD009A          MOD   pgmlen,CharCt,Type,Revs,Entry,Reasize
00017 D 0000           Count   rmb   3           stored in BCD
00018 D 0003           InChr   rmb   1
00019 D 0004           TstChr  rmb   1
00020 D 0005           OutStr  rmb   6
00021 D 000B           CR      rmb   1           for a CR
00022 D 000C                   rmb   200         Stack
00023 D 00D4           Reasize equ   .
00024  0000 43686172   CharCt  fcs   /CharCt/
00025  0013 01                 fcb   1           version
00026       *-------------------------------------------------*
00027       *  At entry:                                      *
00028       *    U and DP point at local storage.             *
00029       *    X points at the parameter area.              *
00030       *-------------------------------------------------*
00031  0014           Entry
00032  0014 0F00              clr   Count
00033  0016 0F01              clr   Count+1
00034  0018 0F02              clr   Count+2
00035  001A A684              lda   ,X
00036  001C 9704              sta   TstChr
00037  001E 3043              leax  InChr,U
00038  0020 108E0001          ldy   #1          characters to read
00039  0024           Loop
00040  0024 8600              lda   #0          std in
00041  0026 103F89            OS9   I$READ
00042  0029 251E              bcs   Quit
00043  002B D603              ldb   InChr
00044  002D D104              cmpb  TstChr
00045  002F 26F3              bne   Loop
00046       *-------------------------------------------------*
00047       *             Increment Count                     *
00048       *-------------------------------------------------*
00049  0031 8601              lda   #1
00050  0033 9B02              adda  Count+2
00051  0035 19                daa
00052  0036 9702              sta   Count+2
00053  0038 8600              lda   #0
00054  003A 9901              adca  Count+1
00055  003C 19                daa
00056  003D 9701              sta   Count+1
00057  003F 8600              lda   #0
00058  0041 9900              adca  Count
00059  0043 19                daa
00060  0044 9706              sta   Count
00061  0046 4F                clra              std in
00062  0047 20DB              bra   Loop
00063       *-------------------------------------------------*
00064       *  If we reaches EOF print the total count and    *
00065       *  exit.                                          *
00066       *  If some other caused us to stop, Return        *
00067       *  with an error code.                            *
00068       *-------------------------------------------------*
00069  0049           Quit
00070  0049 C1D3              cmpb  #E$EOF
00071  004B 2636              bne   Exit
00072  004D 3045              leax  OutStr,U
00073  004F 9600              lda   Count
00074  0051 BD33              bsr   Cnvt
00075  0053 9601              lda   Count+1
00076  0055 BD2F              bsr   Cnvt
00077  0057 9602              lda   Count+2
00078  0059 BD2B              bsr   Cnvt
00079  005B 3045              leax  OutStr,U
00080  005D 960A              lda   OutStr+5    mark last position in OutStr
00081  005F 8A80              ora   #$80        set carry bit
00082  0061 970A              sta   OutStr+5
00083  0063 108E0007          ldy   #7          length
00084  0067 8630              lda   #'0
00085  0069           FndLen
00086  0069 A184              cmpa  ,X
00087  006B 2606              bne   OutPut
00088  006D 313F              leay  -1,Y        decrease length
00089  006F 3001              leax  1,X
00090  0071 20F6              bra   FndLen
00091  0073           OutPut
00092  0073 8600              lda   #$0D        <CR>
00093  0075 9708              sta   CR
00094  0077 960A              lda   OutStr+5
00095  0079 847F              anda  #$7F        clear the carry bit out
00096  007B 970A              sta   OutStr+5
00097
00098  007D 8601              lda   #1          std out
00099  007F 103F8C            OS9   I$WRITLN
00100  0082 5F                clrb              clean up for exit
00101  0083           Exit
00102  0083 103F06            OS9   F$Exit
```

```
        0086             Cnvt
        0086 1F89                 tfr    A,B
        0088 44                   lsra             shift the high order nible into low
        0089 44                   lsra
        008A 44                   lsra
        008B 44                   lsra
        008C 8B30                 adda   #'0       convert to ASCII digit
        008E A780                 sta    ,X+
        0090 C40F                 andb   #$0F      remove high order nyble
        0092 CB30                 addb   #'0       convert to ASCII digit
        0094 E780                 stb    ,X+
        0096 39                   rts
        0097 A10953               EMOD
        009A             Pgmlen   equ    *

00000 error(s)
00000 warning(s)
$009A 00154 program bytes generated
$00D4 00212 data bytes allocated
```

```
PROCEDURE Graphe
0000   DIM process_No,Comp_Code,Opt_Size,Lang_Type:BYTE
0013   DIM Para_L:INTEGER
0016   DIM InPipe,OutPipe:BYTE
0023   DIM chiSTR:[illegible]
0031   DIM [illegible]:STRING
0038   DIM x1,y1,x2,y2:INTEGER
0048   DIM name:STRING
0052   DIM Parms:STRING[120]
005E   (* ---------------------------------------------------*)
009C   (* Set up to call StrtTask which will fork the named *)
00D4   (* module, passing it the parameter string in Parms. *)
0118   (* ---------------------------------------------------*)
0156   name="rast"
0161   process_No=0
0168   Opt_Size=0
016F   Lang_Type=$11 (* attributes of forked module (object code, program)
01AC   Parms=""+CHR$(13)
01B7   Para_L=LEN(Parms) (* The length of the Parameters must be correct
01EF   (* ---------------------------------------------------*)
0230   (* Call assembler subroutines to Fork and wait for the started *)
0273   (* process                                                     *)
02B2   (* ---------------------------------------------------*)
02F3   RUN StrtTask(name,process_No,Lang_Type,Para_L,Parms,Opt_Size       ,InPipe,OutPipe)
0320   (* ---------------------------------------------------*)
0361   (* Write data for "rast" into path #InPipe which     *)
0382   (* corresponds to the standard input path for rast   *)
03E3   (* ---------------------------------------------------*)
0424   PRINT "Enter the endpoints of lines you want drawn. X must be in"
0461   PRINT "the range 0..79, Y must be in the range 0..23."
0493   LOOP
0495     INPUT "Enter X Y coordinates for the ends of a line: ",x1            ,y1,x2,y2
04B7     PRINT "The line will be drawn between (";x1;",";y1;") and ("           ;x2;",";y2;")"
0521     INPUT "OK? Y [illegible] ",r0
053E     [illegible]
0549     IF r0="y" OR r0="Y" THEN
055E       PRINT #InPipe,"l",x1,y1,x2,y2
0570     ENDIF
057A   EXITIF r0="n" OR r0="N" THEN
058F     PRINT #InPipe,"l",x1,y1,x2,y2
05A9   ENDEXIT
05AB   ENDLOOP
05B1   ON ERROR GOTO 100
05B7   CLOSE #InPipe
05BD   (* ---------------------------------------------------*)
05FE   (* When #InPipe is closed rast will get an end-of-file *)
063F   (* on its standard input path.                       *)
0680   (* ---------------------------------------------------*)
06C1   LOOP
06C3     (* -------------------------------------------------*)
0704     (* Read from #OutPipe (which corresponds to rast's standard *)
0745     (* output until end-of-file on that path. The end-of-file *)
0786     (* indicates that the other end of the pipe has been closed *)
07C7     (* (in this case rast has ended).                   *)
0808     (* -------------------------------------------------*)
0849     GET #OutPipe,ch
0853     IF ch="0" THEN
0860       PRINT " ";
0866     ELSE
0860       PUT #1,ch
0873     ENDIF
0875   ENDLOOP
0879 100
0879   ON ERROR
0880   CLOSE #OutPipe
0884   RUN WaitTask(Process_No,Comp_Code)
0895   IF Comp_Code<>0 THEN
08A1     PRINT "Completion code for ";name;" # ";process_No;" was "          ;Comp_Code
08B4   ENDIF
```

```
                          ttl   Start a subtask (called from Basic09)
                          nam   StrtTask
          *-----------------------------------------------------*
          * StrtTask is a subroutine for Basic09.               *
          * Start a named module as a subtask.                  *
          *   Let the new task run asynchronously.              *
          *   Open pipes to the modules standard in and standards
          *   out paths.                                        *
          *  Return the new tasks process number, the path      *
          *  numbers for the pipes, and the condition code      *
          *  from the Fork.                                     *
          * Calling sequence:                                   *
          * run StrtTask (Name, Process Num, Lang_Type,         *
          *              Param_L, Param, Opt_size               *
          *              InPipeN, OutPipeN)                     *
          * Name is any length, but has a valid terminator      *
          *  (high bit set on last byte, or delimiter after it)*
          *                                                     *
          * Process_Num byte field, process number of new task.*
          * Lang_Type byte field, language/type byte for        *
          *  forked module.                                     *
          * Param_L, integer field. length of parameter area.  *
          * Param field of any type. parameter area to be       *
          *  passed to forked process.                          *
          * Opt_Size byte field, optional data area size in     *
          *  pages.                                             *
          * InPipeN, integer field, path number                 *
          * OutPipeN, integer field, path number                *
          * Process_Num, InPipeN, OutPipeN, and Return_Code     *
          * are altered by StrtTask, no other parameters are.   *
          *-----------------------------------------------------*
                          IFP1
                          ENDC
          ******
          * Offsets to arguements
          *
        0002      ACount    equ   2
        0004      ModuleN   equ   4
        0008      ProcNum   equ   8
        000C      ModType   equ   12
        0010      ParaLen   equ   16
        0014      Parms     equ   20
        0018      MDatSize  equ   24
        001C      InPipeN   equ   28
        0020      OutPipeN  equ   32

        0021      Type      set   SBRTN+OBJCT
        0081      Revs      set   REENT+1
        0000      StdIn     equ   0
        0001      StdOut    equ   1
        0000 87CD0081       mod   TLen,StrtTask,Type,Revs,SEntry,0
        000D 53747274 StrtTask fcs /StrtTask/
        0015 2F504950 Pipe     fcs "/PIPE"
        001A 01                fcb 1             version
        001B      SEntry
        001B EC62           ldd   ACount,S    get param count
        001D 10830008       cmpd  #8          are there 8 params?
        0021 10260083       lbne  BadExit     no; leave now.
          *-----------------------------------------------------*
          *          Set up Pipes for StdIn and StdOut.         *
```

Microware OS-9 Assembler 2.1   11/08/83 23:33:36
StrtTask - Start a subtask (called from Basic09)

```
          *   The procedure is:                                 *
          *        Dup the stdin and stdout paths to save them. *
          *        Close stdin and stdout.                      *
          *        Open /PIPE twice. One will be path 0 the next*
          *             path 1.                                 *
          *        Fork the new process.                        *
          *-----------------------------------------------------*
          * Offsets from S for local storage
        0000      DStdIn    equ   0
        0001      DStdOut   equ   1
        0002      LocalSiz  equ   2
          *
        0025 327E           leas  -LocalSiz,S make space for temp storage
        0027 8600           lda   #StdIn
        0029 103F82         OS9   I$Dup       Dup StdIn
        002C 2570           bcs   BadExit2
        002E A7E4           sta   DStdIn,S
        0030 8601           lda   #StdOut
        0032 103F82         OS9   I$Dup       Dup StdOut
        0035 2574           bcs   BadExit2
        0037 A761           sta   DStdOut,S
```

```
00084  0039 8600              lda   #StdIn
00085  003B 103F8F            OS9   I$Close    Close StdIn
00086  003E 2568              bcs   BadExit2
00087  0040 8601              lda   #StdOut
00088  0042 103F8F            OS9   I$Close    Close StdOut
00089  0045 2564              bcs   BadExit2
00090
00091  0047 308DFFCA          leax  Pipe,PCR
00092  004B 8603              lda   #UPDAT.
00093  004D 103F84            OS9   I$Open     Open a pipe in path 0
00094  0050 2559              bcs   BadExit2
00095                 * This will be path 0
00096
00097  0052 308DFFBF          leax  Pipe,PCR
00098  0056 8603              lda   #UPDAT.
00099  0058 103F84            OS9   I$Open     Open a pipe in path 1
00100  005B 254E              bcs   BadExit2
00101                 * This will be path 1
00102  005D 103F82            OS9   I$Dup      Dup it
00103  0060 2549              bcs   BadExit2
00104  0062 A7F822            sta   [LocalSiz+OutPipeN,S]
00105
00106  0065 8600              lda   #StdIn
00107  0067 103F82            OS9   I$Dup      Dup it
00108  006A 253F              bcs   BadExit2
00109  006C A7F81E            sta   [LocalSiz+InPipeN,S]
00110
00111  006F AE66              ldx   LocalSiz+ModuleN,S address of module name
00112  0071 10AEF812          ldy   [LocalSiz+ParmLen,S] length of parameters
00113  0075 A6F80E            lda   [LocalSiz+ModType,S] type of module to invoke
00114  0078 E6F81A            ldb   [LocalSiz+MDatSize,S] optional data area size
00115  007B EEE816            ldu   LocalSiz+Parms,S  pointer to parameters
00116  007E 103F03            OS9   F$Fork     start the new process
00117  0081 2528              bcs   BadExit2
00118  0083 A7F80A            sta   [LocalSiz+ProcNum,S] save new process number
00119          *-------------------------------------------------*
00120          *   Restore the original stdin and stdout files to  *
00121          *   paths 0 and 1.                                  *
00122          *-------------------------------------------------*
00123  0086 8600              lda   #StdIn     Close StdIn and StdOut
00124  0088 103F8F            OS9   I$Close
00125  008B 8601              lda   #StdOut
00126  008D 103F8F            OS9   I$Close
00127  0090 A6E4              lda   DStdIn,S   path number of duped stdin
00128  0092 103F82            OS9   I$Dup      dup it into path 0
00129  0095 A6E4              lda   DStdIn,S
00130  0097 103F8F            OS9   I$Close    and close it
00131  009A A661              lda   DStdOut,S  path number of duped stdout
00132  009C 103F82            OS9   I$Dup      dup it into path 1
00133  009F A661              lda   DStdOut,S
00134  00A1 103F8F            OS9   I$Close    and close it
00135  00A4 3262              leas  LocalSiz,S clear stack
00136  00A6 5F                clrb             clear carry
00137  00A7 39                rts              return
00138  00A8           BadExit
00139  00A8 43                coma             set carry
00140  00A9 327E              leas  -LocalSiz,S dummy push
00141  00AB           BadExit2
00142  00AB 3262              leas  LocalSiz,S clear stack
00143  00AD 39                rts              return
00144  00AE 239951            EMOD
00145  0081           TLen    equ   *
00146                         ttl   Wait for a (child) process to complete
00147                         nam   WaitTask
00148          *-------------------------------------------------*
00149          *  WaitTask is a subroutine for Basic09           *
00150          *  Wait for the a child process to complete.      *
00151          *  Return the process ID of the process that completed*
00152          *  in parameter one.                              *
00153          *  Return the completion code of the process      *
00154          *  in parameter two.                              *
00155          *  This subroutine will wait using no CPU time until *
00156          *  a child process completes.                     *
00157          *  If a child completed just before WaitTask was  *
00158          *  called, it will return almost immediatly.      *
00159          *  If there are no children, an error will be returned*
00160          *  with a process number of 0.                    *
00161          *  Calling sequence:                              *
00162          *   RUN WaitTask (Process_No, Comp_Code)          *
00163          *  both process_no and Comp_Code are BYTE variables. *
00164          *-------------------------------------------------*
00165  0021           Type    set   SBRTN+OBJCT
00166  0081           Revs    set   REENT+1
00167  0000 87CD0032          mod   WLen,WaitTask,Type,Revs,WEntry,0
00168  0000 57616974  WaitTask fcs   /WaitTask/
00169  0015 01                fcb   1          edition
00170  0016           WEntry
00171  0016 6FF804            clr   14,S1      zero the process ID
00172  0019 EC62              ldd   2,S        param count
00173  001B 10830002          cmpd  #2         if not exactly 2 params then
00174  001F 260C              bne   WBExit2    the caller is making a bad mistake
00175  0021 103F04            OS9   F$Wait     wait for a child
00176  0024 2508              bcs   WBExit
00177  0026 A7F804            sta   14,S1      return the process ID
00178  0029 E7F808            stb   [8,S]      return the completion code
00179  002C 39                rts              return
00180  002D           WBExit2
00181  002D 43                coma             set carry
00182  002E           WBExit
00183  002E 39                rts              return
00184  002F 4C34C4            EMOD
00185  0032           WLen    equ   *
00186                         end

00000 error(s)
00000 warning(s)
$00E3 00227 program bytes generated
$0000 00000 data bytes allocated
$2188 08587 bytes used for symbols
```

```
 1 #include <stdio.h>
 2 #define XDIMENSION 24
 3 #define YDIMENSION 80
 4 #define BYTES_YDIMENSION/8
 5 #define TRUE 1
 6 #define FALSE 0
 7 /*-------------------------------------------------------*
 8  *                  Data Structure                       *
 9  * The rasterized data is kept in an array of bits.      *
10  * The SetBit and BitSet routines are responsible for    *
11  * determining which bit corresponds to each             *
12  * position.  They also are the only procedures with     *
13  * access to the "bit" array.                            *
14  *-------------------------------------------------------*/
15 main()
16 {
17 int x1, y1, x2, y2;
18 int i;
19 char op;  /* takes values of  L  Line  (n,n,n,n)
20                               C  Circle (n,n,0,0)
21                               S  Spline (open) (n,n,n,n,n,n)
22                               E  Spline (closed) (n,n,n,n,n,n)
23          */
24 register int j;
25
26 while (scanf("%c %d %d %d %d",&op, &x1,&y1, &x2,&y2) != EOF)
27 /*  Ignore "op" for now */
28    if (x1 < x2)
29       draw(x1,x2,y1,y2);
30    else
31       draw(x2,x1,y2,y1);
32
33 for (i=YDIMENSION-1;i>=0;i--)
34    {
35       for (j=0;j<XDIMENSION;j++)
36          putchar(bitset(j,i) ? '1' : '0');
37       printf("\n");
38    }
39 return;
40 } /* end of main */
41
42 draw(x1,x2,y1,y2)
43    int x1, x2, y1, y2;
44    {
45       int deltay, deltax, x, y, dy, dx;
46       float e, slope;
47       register int i;
48
```

```
49      deltay = y2-y1;
50      deltax = x2-x1;
51      x = x1;
52      y = y1;
53      if ((deltax == deltay) && (deltay == 0))
54         { /* special case -- draw a point */
55           plot(x,y);
56           return;
57         }
58
59      if (deltax > deltay)
60         {
61           if (deltax == 0)
62              { /* prevent division by zero */
63                y = (y1 <= y2) ? y1 : y2;
64                for (j=0;j<=((deltay >= 0) ? deltay : -deltay);j++)
65                   plot(x,y++);
66                return;
67              }
68           slope = ((float)deltay/(float)deltax;
69           if (slope >= 0)
70              {
71                e = slope-0.5;
72                dy = 1;
73              }
74           else
75              {
76                e = slope+0.5;
77                dy = -1;
78              }
79           for (i=0; i<=deltax; i++)
80              { /* actually draw the line */
81                plot(x,y);
82                if (((slope > 0.0) && (e>0.0)) ||
83                    ((slope < 0.0 ) && (e<0.0)))
84                   {
85                     y += dy;
86                     e -= dy;
87                   }
88                x++;
89                e += slope;
90              } /* actually draw the line */
91         }
92      else
93         {
94           slope = ((float)deltax/(float)deltay;
95           if (slope > 0)
96              {
97                e = slope-0.5;
98                dx = 1;
99              }
100          else
101             {
102               e = slope+0.5;
103               dx = -1;
104             }
105          for (i=0; i<=deltay; i++)
106             { /*----------------------------------*
107               * draw a line with slope greater than one *
108               * for this type of line y needs to be     *
109               * incremented more frequently than x.     *
110               *-----------------------------------*/
111               plot(x,y);
112               if (((slope > 0) && (e>0)) || ((slope < 0 ) && (e<0)))
113                  {
114                    x += dx;
115                    e -= dx;
116                  }
117               y++;
118               e += slope;
119             }
120        }
121     return;
122  } /* end of draw */
123
124 plot(x,y)
125    int x,y;
126    {
127       setbit(x,y);
128       return;
129    }
130
131 static char bit[YDIMENSION][BYTES];
132
133 setbit(x,y)
134    int x,y;
135    {
136       int temp=1;
137       register int tx;
138
139       temp = temp << (x%8);
140       tx = x/8;
141       bit[y][tx] = bit[y][tx] | temp;
142       return;
143    }
144
145 bitset(x,y)
146    int x,y;
147    {
148       int temp=1;
149
150       temp = temp << (x%8);
151       return(bit[y][x/8] & temp);
152    }
153
```

A BASIC09 FINANCIAL MODELING PROGAM

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COMPSHEET

Have you ever had trouble convincing people that your home computer is really useful ? I am absolutely certain that they are great, but I sometimes have a little bit of difficulty convincing my wife of their value. Of course it doesn't help that she dislikes numbers, hates math, and feels that it is terrible to spend perfectly nice days (of which we have quite a few here in Colorado) cooped up indoors typing at a terminal. Besides, I have to admit, not all of the things I do with my machine are strictly useful. Take the voice synthesizer for example. It was fun to type in a half page of funny characters and then hear it try to sing Happy Birthday, but it didn't really serve any very useful purpose.

Given this background you will no doubt appreciate that I am always eager to find some useful task for my home computer to perform. And, amazingly, the chance finally came about a year ago. My wife signed up for a class on Financing Real Estate only to discover that what she had thought would be a fun and interesting course was full of numbers and calculations (the professor casually suggested that all the students buy $150 HP Financial calculators). One Saturday, after I had spent all afternoon (on a perfectly nice Colorado day, mind you) helping her go through detailed calculations showing how to make the most profit on financing a shopping center, it occurred to me that this was the sort of thing that computers were invented for. All we needed was one of those nifty spreadsheet programs. But how could I convince my wife that it made sense to spend considerably more than $150 on a spreadsheet program that she couldn't even take to class with her? "That's easy! I'll just write one myself. You can't trust other people's programs anyway", I said to myself.

I promised it wouldn't take more than about 2 hours (she was skeptical. She had to turn in the results Monday night and Saturday was already gone). Well, as you can certainly imagine, these things don't always go as smoothly as one might expect. I worked all day Sunday and late into the night. Finally I helped her do the rest of the calculations on a calculator. But I was determined to finish up the spreadsheet program. Besides, she still had a term project due at the end of the semester. The final result is the COMPSHEET program presented here. In the rest of this article I will give you an overall description of the program and an illustrated example of its use.

Features of COMPSHEET

The first feature of COMPSHEET is that it is cheap (you can type in the accompanying listing or for $10 I will send you a 5" soft sectored OS-9 floppy with the program

on it). It is definitely not a full-fledged spreadsheet program but it does help quite a bit in doing complicated financial calculations and projections over a period of years. On my 56K OS-9 (trademark of Microware) Level I machine, the program can only handle 30 rows of 20 columns each, but that is plenty for many situations. If you have a Level II system, you could no doubt increase this.

The program is written in Microware's excellent BASIC09 (trademark of Microware and Motorola) language. A few of the features of this BASIC which are used in the program include user defined variable types (which can be used like PASCAL records) and a true subroutine capability (none of this hokey GOSUB stuff for me!). The ample collection of "structured programming" constructs available in BASIC09 is also put to good use. You will note the absence of any program numbers in the program. Another substantial advantage of BASIC09 is its impressive speed. There is very little delay while COMPSHEET does its calculations. Obviously, writing a program in BASIC makes it much easier to try out changes and improvements to the code.

The program allows you to give a name (which can be used in formulas to calculate the values of future rows), a title (which will be printed out), a method of calculation for the values to be placed in the row (more about this in a minute), and miscellaneous formatting instructions pertaining to how the row will appear on the output. The values for a given row can be specified directly with a list of numbers, or you can specify the number for the first column in the row and let COMPSHEET add an increment or inflation factor to this to calculate values for the remaining columns in the row. The final choice is to give COMPSHEET a formula involving previous rows and or numbers. Formulas can include the four basic arithmetic operators + - * and /. You can also specify title lines or other alphanumeric information to make the final spreadsheet clear to the user (remember, my wife had to understand the results of all this).

Three formats are provided for output numbers - dollar (commas are inserted as appropriate and negative numbers are enclosed in parentheses), numeric (just plain old numbers), and percent (this also affects how input numbers are treated). Of course, columns are nicely justified to make things look neat.

One thing the program doesn't do is to allow you to move around on the screen and change things interactively (I told you this was not a full-blown commercial spreadsheet). Once you have typed something in you are stuck with it. However, all of your input is automatically saved in a file so that you can edit it later. "Wouldn't it be nice if I could afford an editor?", you say. With COMPSHEET that is no problem! The file that your input is saved in can be edited with the editor that comes as a part of BASIC09. Once you have made any changes to your input you can run COMPSHEET on the file. As it reads through the file the program lists the lines to your terminal so that you can see what it is working on.

A Practical Example

In order to keep things simple I won't go through a whole shopping center example. Let's just suppose that you are thinking of buying some vacant land with the intention of subdividing it into building lots in a couple of years. The land will cost you $50,000 and you can get a 25 year 14% loan on it for 80% of that amount (don't ask me how or where). Further, we will assume that with about $10,000 of development expenses you could resell the land as three lots for $30,000 each in the third year of ownership. There are several numbers we need to calculate before we are ready to fire up COMPSHEET. First, we need to know what yearly payments on the loan will come to, and how much of these will represent payment of interest (interest payments are tax deductible). This can be found from a standard amortization table or a simple program. In our case, yearly payments (referred to as debt service in real estate jargon) come to $5778. Of this amount, $5588 goes to interest in the first year, $5560 goes to interest in the second year, and $5527 in the third year. The difference between these amounts and the yearly debt service payments represents paydown of the principal and amounts to a grand total of $659 over the first three years.

Now, with these numbers in hand, we are ready to begin our calculations. First, we will calculate before tax cash flows, then the Federal Income Tax ramifications of the investment, and finally the all-important after tax cash flow (ATCF).

From a cash point of view the initial investment is the difference between the total cost of the land ($50,000) and the amount of your loan ($40,000). Although this number is not used in calculating cash flows it is certainly useful to bear in mind.

For the first two years the cash flow will be comprised only of the annual debt service (in most areas of the country you would also have to pay property taxes, but we will leave those out for simplicity). However, in the third year, there will be some income (estimated at $90,000) from the sale of the lots. In addition, we anticipate expenses of $10,000 to develop the lots. Combining all of these items we calculate the before tax cash flow which, for reasons which are unclear, is generally termed the cash throwoff to equity or CTOE.

Now we must deal with the tax consequences of this investment. These consist of a deduction for our interest expenses and longterm capital gains treatment for our profit (which is charged at only 40% of the rate for normal income). The profit consists of the $90,000 we sell the lots for minus the original price of $50,000 we paid minus our $10,000 development expenses (note that only the interest portion of our debt service payments counts as an expense - the rest went into paying off the mortgage). So we end up with a $30,000 longterm capital gain (LTCG). Combining the interest deductions and the LTCG we calculate the annual taxable amount relative to this investment and assume we are in the 50% tax bracket in order to figure the final tax liability (or savings). This amount is then combined with the CTOE calculated previously to yield the ATCF.

Let me make it clear that I am not an accountant and the details of the above tax treatment may not be entirely accurate. However they serve adequately as an example of what COMPSHEET can do for you.

Listing of Input to COMPSHEET

```
PROCEDURE example
0000      REM ^3
0005      REM ^15
000B      REM ^50
0011      REM ^center
001B      REM ^COMPSHEET Example
0030      REM ^center
003A      REM ^==================
004F      REM ^literal
005A      REM ^
005E      REM ^literal
0069      REM ^Assumptions :
007A      REM ^literal
0085      REM ^
0089      REM ^literal
0094      REM ^      Initial purchase price of $50,000.
00C0      REM ^literal
00CB      REM ^      Loan for $40,000 at 14% over 25 years.
00FB      REM ^literal
0106      REM ^
010A      REM ^literal
0115      REM ^
011A      REM ^literal
0125      REM ^                    Year 1     Year 2     Year 3
0150      REM ^underline
0165      REM ^row
016C      REM ^income
0176      REM ^Sale of lots
0186      REM ^0
018B      REM ^0
0198      REM ^90000
0199      REM ^row constant
01A9      REM ^ds
01AF      REM ^- Debt service
01C1      REM ^-5778
01CA      REM ^row
01D1      REM ^devel
01DA      REM ^- Developeent expenses
01F4      REM ^0
```

```
01F9    REM ^0
01FE    REM ^-10000
0200    REM ^row
020F    REM ^repay
0210    REM ^- Loan repayment
022C    REM ^0
0231    REM ^0
0236    REM ^-39341
0240    REM ^underline
024D    REM ^row formula
025C    REM ^ctoe
0264    REM ^CTOE
026C    REM ^income + ds + devel + repay
0288    REM ^literal
0296    REM ^
0298    REM ^row hide
02A7    REM ^gain
02AF    REM ^
02B3    REM ^0
02B8    REM ^0
02BD    REM ^90000 - 50000 - 10000
02D6    REM ^row formula
02E5    REM ^ltg
02EC    REM ^Longterm gain @ 40%
0303    REM ^gain * 0.40
0312    REM ^row
0319    REM ^int
0320    REM ^- Interest
032E    REM ^-5500
0337    REM ^-5560
0340    REM ^-5527
0349    REM ^underline
0356    REM ^row formula
0365    REM ^taxamnt
0370    REM ^Taxable amount
0382    REM ^ltg + int
038F    REM ^row constant percent
03A7    REM ^taxrate
03B2    REM ^Tax rate
03BE    REM ^50
03C4    REM ^underline
03D1    REM ^row formula
03E0    REM ^taxliab
03EB    REM ^Tax liability
03FC    REM ^taxamnt * taxrate
0411    REM ^literal
041C    REM ^
0421    REM ^row formula
0430    REM ^
0435    REM ^CTOE
043D    REM ^ctoe
0445    REM ^row formula
0454    REM ^
0459    REM ^- Tax liability
046C    REM ^-taxliab
0478    REM ^underline
0485    REM ^row formula
0494    REM ^atcf
049C    REM ^ATCF
04A4    REM ^ctoe - taxllab
```

Listing of Output from Example

```
                COMPSHEET Example
                =================

Assumptions :

     Initial purchase price of $50,000.
     Loan for $40,000 at 14% over 25 years.

                          Year 1      Year 2      Year 3
-------------------------------------------------------
Sale of lots                   0           0     90,000

- Debt service           (5,770)     (5,770)     (5,770)

- Development
expenses                       0           0    (10,000)

- Loan
repayment                      0           0    (39,341)
-------------------------------------------------------

CTOE                     (5,770)     (5,770)     34,001


Longterm gain
@ 40%                          0           0     12,000

- Interest               (5,500)     (5,560)     (5,527)
-------------------------------------------------------

Taxable amount           (5,500)     (5,560)      6,473

Tax rate                  50.00%      50.00%      50.00%
-------------------------------------------------------

Tax liability            (2,794)     (2,780)      3,237


CTOE                     (5,770)     (5,770)     34,001

- Tax liability           2,794       2,780      (3,237)
-------------------------------------------------------

ATCF                     (2,984)     (2,990)     31,645
```

Comments on Example

Refer to the listing included of input to COMPSHEET in this discussion of the example. The listing was produced inside BASIC09 as the memory locations referenced provide an easy way to refer to individual lines within the file. Note that each line begins with REM @. This is added by COMPSHEET at the beginning of each line that you type in to make it look like a valid BASIC09 statement so that you can use the editor inside BASIC09 to edit the file. The first three lines describe the number of columns, how many characters to allow for alphanumeric labels on each row, and the total paper width to use. After this, succeeding lines alternate between COMPSHEET commands (such as CENTER, LITERAL, ROW, or NUMBER) and the data needed by these commands. In the case of the UNDERLINE command, no data is needed. For CENTER and LITERAL one line of text

constitutes the data, while for ROW or NUMBER the data consists of a line with the item name (which if nonblank can be used later to refer to this item in formulas), then a line with the label to print at the left of this item, and finally the numbers for this item (or the formula or a base value and increment or a base value and percentage increase depending on which option was selected along with the command).

Of special interest are the lines at 02 B - 02BD. Here we declare a row as "HIDE". This tells COMPSHEET to go ahead and calculate everything for this row, but not to display it. This feature can be used to simplify the visual appearance of the output. Note also that the labels specified at lines 01DA and 02EC are neatly split at word boundaries since they are too long to fit within the number of characters we specified for labels.

SUMMARY

This program does not claim to provide the features of a commercial spreadsheet program. However, I believe that many readers may find it useful for relatively simple computations. It provides a neat output with several different options for number formatting. Features such as the powerful editor built into BASIC09 help to keep the program simple, and enables it to fit entirely in memory. Because the program takes advantage of BASIC09's ability to handle separate subprograms it will be relatively easy for users to customize the package to their own needs. Anyone interested in getting a 5" inch floppy containing this program may do so by sending $10 to the author.

Listing of COMPSHEET

```
PROCEDURE compsheet
TYPE item_type=name:BYTE;NULL(8);values(20):REAL
DIM item(30):item_type
REM The above 2 lines allow up to 20 years and 30 items
DIM command(5):BYTE;NULL(8)
DIM qualifiers(0):STRING[8]
DIM q1,q2,q3,toktype:INTEGER
DIM inline,outline,temp$:STRING[265]
DIM file,out,prt:INTEGER
DIM bfile:BOOLEAN
DIM title_size,column_size:INTEGER
DIM syrs,atyrs:INTEGER
atyrs=1
DIM i,j,k,lineno:INTEGER
REM Find out whether they want input from terminal or file.
PRINT "Do you have an existing file for input "
INPUT c$
IF LEFT$(c$,1)="Y" OR LEFT$(c$,1)="y" THEN
PRINT "Filename "
INPUT c$
OPEN #file,c$:READ
bfile=TRUE
READ #file,inline \REM skip over dummy Procedure line
CREATE #out,"/term":WRITE
ELSE
PRINT "Filename to save in "
INPUT c$
OPEN #file,"/term":UPDATE
bfile=FALSE
CREATE #out,c$:WRITE
WRITE #out,"PROCEDURE "+c$ \REM Write out dummy Procedure line
ENDIF
RUN getint(file,file,out,syrs,"How many years (1-20) ? ")
RUN getint(bfile,file,out,title_size,"How many columns for names ? "
)
RUN get1st(bfile,file,out,column_size,"How many columns wide is paper ? "
)
column_size=(column_size-title_size)/syrs
DATA "LITERAL","CENTER","UNDERLINE","NUMBER","ROW"
FOR i=1 TO 5
READ command$(i)
NEXT i
DATA "LIST","CONSTANT","INCREMENT","INFLATE","FORMULA","DOLLARS"
,"PERCENT","NUMERIC"
FOR i=1 TO 8
READ qualifier$(i)
NEXT i
lineno=1
CREATE #prt,c$+".prt":WRITE \REM Create file to be printed later
WHILE NOT(EOF(bfile)) DO  \REM Here is the main loop of processing command lines
RUN getline(bfile,file,out,inline,TRUE,"Command : ") \REM Get next command
j=0:temp$=" "+inline \REM Find end of first word
IF j<0 THEN j=LEN(inline)+1 \REM There may only be 1 word
ENDIF
code$=LEFT$(inline,j-1) \REM Extract command word
inline=MID$(inline,j+1,265-j)
FOR j=1 TO 5 \REM Check against legal commands
EXITIF code$=command$(j) THEN i=j
ENDEXIT
IF j=5 THEN i=0 \REM Set i = 0 to indicate no match
ENDIF
NEXT j
IF i=1 THEN  \REM LITERAL command
RUN getline(bfile,file,out,inline,FALSE,"Literal line : ")
PRINT #prt,inline \REM Print it out
ENDIF
IF i=2 THEN  \REM CENTER command
RUN Getline(bfile,file,out,inline,FALSE,"Line to center : ")
REM Calculate how many leading blanks we need
j=(title_size+syrs*column_size-LEN(TRIM$(inline)))/2+1
PRINT #prt,TAB(j);inline
ENDIF
IF i=3 THEN  \REM UNDERLINE command
FOR j=1 TO title_size+syrs*column_size
PRINT #prt,"_";
NEXT j
PRINT #prt,""
ENDIF
IF i=0 OR i=3 THEN  \REM NUMBER or ROW command
q1=1 \REM 1 => calculation of value by LIST of values
q2=1 \REM 1 => format is DOLLARS by default
q3=1 \REM 1 => HIDE is false by default
FOR i=1 TO 5 \REM Compare for calculation of value qualifier
k=INSTR(qualifier$(j),inline)
IF k>0 THEN
q1=j
ENDIF
NEXT j
FOR j=6 TO 8 \REM Compare for format qualifier
k=INSTR(qualifier$(j),inline)
IF k>0 THEN
q2=j-5
ENDIF
NEXT j
IF INSTR("HIDE",inline)>0 THEN q3=0 \REM Check for HIDE qualifier
ENDIF
RUN getline(bfile,file,out,inline,TRUE,"Item name : ")
item(lineno).name=LEFT$(inline,10) \REM Keep only first 10 chars
RUN getline(bfile,file,out,inline,FALSE,"Item title : ")
IF q3>0 THEN  \REM If not HIDing list out title
PRINT #prt," "
REM If title is too long for 1 line break it at word boundary
WHILE (LEN(inline))title_size DO
jj=title_size+1 \REM Assume first word of title is too long
FOR j=title_size TO 1 STEP -1
EXITIF MID$(inline,j,1)=" " THEN jj=j
ENDEXIT
NEXT j
IF jj<title_size THEN  \REM We found a break point
PRINT #prt,LEFT$(inline,jj-1)
inline=MID$(inline,jj+1,267-jj)
ELSE  \REM We must hyphenate. Don't try to use rules
PRINT #prt,LEFT$(inline,jj-2)+"-"
inline=MID$(inline,11-1,267-jj)
ENDIF
ENDWHILE
PRINT #prt,TAB(11-LEN(inline));TAB(title_size+11)  \REM Finish title & space over
ENDIF
IF q1<5 THEN  \REM If LIST of values, CONSTANT, INCREMENT, or INFLATE
RUN getline(bfile,file,out,inline,TRUE,"Initial value : ")
RUN evaluate(inline,1,lineno,item,base_val)
If q2=2 THEN base_val=base_val/.01 \REM Divide by 100 for percent
ENDIF
ENDIF
ENDIF
IF i=0 THEN  \REM NUMBER item
IF q1=5 THEN  \REM FORMULA
RUN Getline(bfile,file,out,inline,TRUE,"Give the formula : ")
RUN evaluate(inline,1,lineno,item,base_val)
ENDIF
FOR j=1 TO syrs \REM For NUMBER each year is the same
item(lineno).value(j)=base_val
NEXT j
IF q3>0 THEN  \REM If not HIDE
RUN format(prt,q2,1,column_size,item(lineno))
PRINT #prt,"" \REM End the line
ENDIF
REM Only remember this item if they gave it a name
IF item(lineno).name<>"" THEN
lineno=lineno+1
ENDIF
ENDIF
IF i=5 THEN  \REM ROW
IF q1=1 THEN  \REM LIST of values
item(lineno).value(1)=base_val
FOR j=2 TO syrs
PRINT USING "'Value for year',I3,$3":j," : ";
RUN getline(bfile,file,out,inline,TRUE,"")
RUN evaluate(inline,j,lineno,item,item(lineno).value(j))
REM Divide by 100 if this is to PERCENT
```

```
IF a2=2 THEN item(lineno).values(j)=item(lineno).values(j)*.01
ENDIF
NEXT j
ENDIF
IF a1=2 THEN  \REM COMPTAN
FOR j=1 TO myrs
item(lineno).values(j)=base_val
NEXT j
ENDIF
IF a1=3 THEN  \REM INCREMENT
RUN getline(bfile,file,out,inline,TRUE,"Increment : ")
RUN evaluate(inline,1,lineno,item,incr
incr=0
FOR j=1 TO myrs
item(lineno).values(j)=base_val+incr
incr=incr+inc
NEXT j
ENDIF
if a1=4 THEN  \REM INFLATE
RUN getline(bfile,file,out,inline,TRUE,"Percentage rate : ")
RUN evaluate(inline,1,lineno,item,incr
incr=1
incr=incr+.01*1.
FOR j=1 TO myrs
item(lineno).values(j)=base_val*incr
incr=incr*inc
NEXT j
ENDIF
IF a1=5 THEN  \REM FORMULA
RUN getline(bfile,file,out,inline,TRUE,"Formula : ")
temp1ine=inline \REM Save the formula
FOR j=1 TO myrs
inline=temp1ine
RUN evaluate(inline,j,lineno,item,base_val)
item(lineno).values(j)=base_val
NEXT j
ENDIF
IF a1>0 THEN  \REM Not WIDE
RUN format(dot,87,myrs,column_size,item(lineno))
PRINT #p,t,"" \REM End the line
ENDIF
REM Only remember this line if they gave it a name
IF item(lineno).name$<>"" THEN
lineno=lineno+1
ENDIF
ENDIF
IF i<0 THEN  \REM Here then of bad line
PRINT "Input line contains no command ignored : "; inline
ENDIF
ENDWHILE
CLOSE #file
CLOSE #out
CLOSE #art
BYE
PROCEDURE getline
PARAM bfile:BOOLEAN
PARAM file,out:INTEGER
PARAM inline:STRING[265]
PARAM upcase:BOOLEAN
PARAM prompt:STRING
DIM i,j:INTEGER
inline=""
IF EOF(#file) THEN END
ENDIF
IF bfile THEN
READ #file,inline
inline=MID$(inline,0,266-5) \REM Strip off dummy REM "
WRITE #out,inline
ELSE
PRINT #file,prompt
READ #file,inline
WRITE #out,"REM "+inline \REM Insert dummy REM "
ENDIF
IF upcase THEN
RUN CVUpper(inline)
ENDIF
END
PROCEDURE token
PARAM inline:STRING[265]
PARAM toktype:INTEGER
PARAM str:STRING
PARAM value:REAL
DIM i,j:INTEGER
i=1
str=" "
value=0
IF inline="" THEN
toktype=0 \REM =) no token. Just return
END
ENDIF
REM Strip leading blanks
WHILE LEFT(inline,1)=" " DO
inline=MID$(inline,2,264)
ENDWHILE
c$ LEFT$(inline,1)
REM Check for item name
IF "A"<=c$ AND c$<="Z" THEN
toktype=2 \REM =) item name found
str=" "
REM Retrieve rest of item name
WHILE "A"<=c$ AND c$<="Z" DO
str=STR$(str+c$)
inline=MID$(inline,2,264)
c$=LEFT$(inline,1)
ENDWHILE
ELSE
REM Other possibilities are a number or an operator
IF "0"<=c$ AND c$<="9" OR c$="." THEN
toktype=1 \REM =) a number
value=0
REM Handle leading digits
WHILE "0"<=c$ AND c$<="9" DO
value=value*10+ASC(c$)-ASC("0")
inline=MID$(inline,2,264)
c$=LEFT$(inline,1)
ENDWHILE
REM Check for decimal point.
IF c$="." THEN
REM If found, strip it out
inline=MID$(inline,2,264)
c$=LEFT$(inline,1)
place=1.
REM and handle fraction digits.
WHILE "0"<=c$ AND c$<="9" DO
place=place*.1
value=value+(ASC(c$)-ASC("0"))*place
inline=MID$(inline,2,264)
c$=LEFT$(inline,1)
ENDWHILE
ENDIF
ELSE
toktype=3 \REM =) an operator
str=c$
inline=MID$(inline,2,264)
c$=LEFT$(inline,1)
ENDIF
ENDIF
END
PROCEDURE copper
PARAM inline$[STRING[265]
DIM i,n:INTEGER
n=LEN(inline$
FOR i=1 TO n
c$=MID$(inline$,i,1)
IF "a"<=c$ AND c$<="z" THEN
inline$=LEFT$(inline$,i-1)+CHR$(ASC(c$)+ASC("A")-ASC("a"))+MID$(inline$
,(i+1),n-i)
ENDIF
NEXT i
END
PROCEDURE evaluate
type line_type=case[STRING[100]] values[20]:REAL
PARAM inline:$STRING[265]
PARAM start:INTEGER
PARAM linenum:INTEGER
PARAM item[3]:item_type
PARAM value:REAL
DIM j,toktype:INTEGER
value=0 \REM Start off as 0. We will add to it.
op$="" \REM Implied addition before first operand!
RUN token(inline,toktype,c$,value)
WHILE toktype>0 DO  \REM While there are tokens on the line
IF toktype=3 THEN  \REM OPERATOR
op$=c$ \REM Save operator for later use.
ELSE
IF toktype=2 THEN  \REM item NAME
FOR j=1 TO lineno-1 \REM Find this name in our list.
EXITIF item[j].name$=c$ THEN value=item[j].values[start]
ENDEXIT
IF j=lineno-1 THEN
PRINT "Formula involved unrecognized item name : "; c$
value=0
ENDIF
NEXT j
ENDIF
REM If it was either a NAME or a NUMBER we can now apply the
REM saved operator to it.
IF op$="" THEN
value=value-valu
ELSE
IF op$="+" THEN
value=value+valu
ELSE
IF op$="-" THEN
value=value+valu
ELSE
IF op$="*" THEN
value=value*valu
```

```
ELSE
PRINT "Formula involved unrecognized operator : "; op$
ENDIF
ENDIF
ENDIF
ENDIF
ENDIF
RUN tokenize(line,toktype,c$,value)
ENDWHILE
END
PROCEDURE format
TYPE item_type=name:STRING[10]; values(20):REAL
PARAM prt,q2:INTEGER
PARAM nrrs:INTEGER
PARAM col_size:INTEGER
PARAM item:item_type
DIM i:INTEGER
DIM spaces,stars:STRING[80]
DATA "                                                                                "
DATA "********************************************************************************"
READ spaces
READ stars
FOR i=1 TO nrrs
IF q2=1 THEN
RUN dollars(prt,col_size,item.values(i),spaces,stars)
ENDIF
IF q2=2 THEN
RUN percent(prt,col_size,item.values(i),spaces,stars)
ENDIF
IF q2=3 THEN
RUN numeric(prt,col_size,item.values(i),spaces,stars)
ENDIF
NEXT i
END
PROCEDURE dollars
PARAM prt:INTEGER
PARAM siz:INTEGER
PARAM value:REAL
PARAM spaces,stars:STRING[80]
DIM i,j:INTEGER
DIM neg:BOOLEAN
DIM tval:REAL
DIM str:STRING
tval=value
neg=tval<0
IF neg THEN
tval=-(tval)
ENDIF
i=0 \REM i will count how many characters we need.
j=0 \REM j is used to tell us when we need commas.
tval=tval+.499999
str=CHR$(FIX(MOD(tval,10)-.499999)+ASC("0"))
tval=tval*.1
WHILE 1.<=tval DO
IF j=3 THEN
str=","+str
j=0
i=i+1
ENDIF
str=CHR$(FIX(MOD(tval,10)-.499999)+ASC("0"))+str
i=i+1
j=j+1
tval=tval*.1
ENDWHILE
IF neg THEN
IF i>siz-2 THEN
str=LEFT$(stars,siz-2)
i=siz-2
ENDIF
PRINT #prt,LEFT$(spaces,siz-i-2);
PRINT #prt,"("; LEFT$(str,i); ")";
ELSE
IF i>siz-1 THEN
str=LEFT$(stars,siz-1)
i=siz-1
ENDIF
PRINT #prt,LEFT$(spaces,siz-i-1);
PRINT #prt,LEFT$(str,i); " ";
ENDIF
END
PROCEDURE percent
PARAM prt,siz:INTEGER
PARAM value:REAL
PARAM spaces,stars:STRING[80]
DIM valu:REAL
DIM str:STRING
DIM neg:BOOLEAN
valu=value*10000.
neg=valu<.0
IF neg THEN
valu=-(valu)
ENDIF
REM First handle 2 decimal places.
valu=valu+.499999
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))
valu=valu*.1
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
REM Now insert decimal point
str="."+str
REM Now handle as many digits as we need to left of decimal point
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
WHILE 1.<=valu DO
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
ENDWHILE
j=LEN(TRIM$(str))
IF neg THEN
IF j>siz-2 THEN
str=LEFT$(stars,siz-2)
j=siz-2
ENDIF
PRINT #prt,LEFT$(spaces,siz-j-2);
PRINT #prt,"-"; TRIM$(str); "%";
ELSE
IF j>siz-1 THEN
str=LEFT$(stars,siz-1)
j=siz-1
ENDIF
PRINT #prt,LEFT$(spaces,siz-j-1);
PRINT #prt,TRIM$(str); "%";
ENDIF
END
PROCEDURE numeric
PARAM prt,siz:INTEGER
PARAM value:REAL
PARAM spaces,stars:STRING[80]
DIM valu:REAL
DIM str:STRING
DIM neg:BOOLEAN
valu=value*100.
neg=valu<.0
IF neg THEN
valu=-(valu)
ENDIF
REM First handle 2 decimal places.
valu=valu+.499999
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))
valu=valu*.1
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
REM Now insert decimal point
str="."+str
REM Now handle as many digits as we need to left of decimal point
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
WHILE 1.<=valu DO
str=CHR$(FIX(MOD(valu,10)-.499999)+ASC("0"))+str
valu=valu*.1
ENDWHILE
j=LEN(TRIM$(str))
IF neg THEN
IF j>siz-2 THEN
str=LEFT$(stars,siz-2)
j=siz-2
ENDIF
PRINT #prt,LEFT$(spaces,siz-j-2);
PRINT #prt,"-"; TRIM$(str); " ";
ELSE
IF j>siz-1 THEN
str=LEFT$(stars,siz-1)
j=siz-1
ENDIF
PRINT #prt,LEFT$(spaces,siz-j-1);
PRINT #prt,TRIM$(str); " ";
ENDIF
END
PROCEDURE getint
PARAM batin:BOOLEAN
PARAM file,out:INTEGER
PARAM valu:INTEGER
PARAM prompt:STRING
DIM i,j:INTEGER
DIM dummy:STRING[4]
valu=0
IF EOF(#file) THEN
PRINT "GETINT hit EOF on input!"
END
ENDIF
IF batin THEN
GET #file,dummy
READ #file,valu
WRITE #out,valu
ELSE
PRINT #file,prompt;
READ #file,valu
WRITE #out,"REM "; valu \REM insert dummy REM "
ENDIF
```

EPSON HX—20 REVIEW

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Why review the Epson HX-20 computer in 68 Micro, you ask? Simple - the HX-20 uses the 6301 microprocessor. The 6301 is a CMOS version of the 6803 processor, which is quite similar to the 6800 and definitely a member of the 68xx family.

Like the 6803, the 6301 can run 6800 machine language programs, but it also contains several additional instructions which the 6800 does not have. These are more like those of the 6809. For example, it has ABX (add B to X); LDD, ADDD, STD and other double-accumulator instructions; and PSHX and PULX instructions for saving the contents of the index register on the stack. In addition, the 6301 has a few instructions which even the 6803 does not have - a "sleep" instruction and several bit manipulation instructions. In addition, of course, it is CMOS and so it can easily be used in battery operated systems. The HX-20 is what some call a "portable notebook" or "briefcase" computer, a bit smaller than a 2" thick loose-leaf binder. It has an internal nickel cadmium battery, and thus the 6301 is an ideal processor for such a computer.

The HX-20 sports two of these processors - one for general computing, and the other for controlling some of the specialized I/O devices. In addition, it comes with 16K bytes of RAM (expandable to 32K with a $150 plug-in memory expansion module), and an internal time of day clock. It also includes 40K of ROM, part of which is bank-switched. It comes with a Microsoft Basic interpreter and also an 8K word processor called SkiWriter.

I/O Capability

The HX-20 has a standard typewriter-size keyboard with 56 keys, four additional cursor control keys, three program control buttons, and five function buttons. The keyboard is quite complete, and even includes square and curly brackets, the inverse slash, and other special characters. It can also generate control characters with its CTRL key.

The display is an LCD display of 4 lines by 20 characters across. An angle adjustment control makes the display easy to read even when viewed at strange angles. Though this is a fairly limited display, the HX-20 maintains a "virtual screen" which is typically eight lines by 40 characters, and whose size can be varied. The actual LCD screen can be thought of as a window on this virtual screen, and the cursor control keys can move the window back and forth over the virtual screen. Though this does not solve all the problems of a small display, still it does have many advantages. It's quite handy to be able to go back a few lines above the visible screen to look at something after it has scrolled off the LCD display.

What really makes the HX-20 unique and different from other briefcase style computers (such as the Radio Shack Model 100, which is in about the same category) is its printer and cassette data recorder. Whereas other small machines require external printers and recorders, the HX-20 has them built in.

The printer is a miniature dot matrix unit which prints on 2-1/4" wide adding machine paper. It occupies the top left corner of the computer's front panel. The printer can be used for normal printing; in addition, the Microsoft Basic has a COPY command which can be used to dump the contents of the screen, graphics as well as text, to the printer. Though it is a bit noisy in a quiet room, the printer is not objectionably so, even when running for a while at its maximum speed, which is a bit over one line of text per second.

The second unique I/O device is a microcassette recorder which occupies the top right corner of the front panel. The recorder used to be an extra-cost option, but is now included with the HX-20 as part of the $799 purchase price.

If you think the printer is small, the recorder is even smaller. It has no mechanical controls, since its operation is entirely under computer control. Instructions in the program can stop and start it, and the function keys also double for recorder control. Though smaller, this recorder is much more capable than the larger cassette recorders connected to other computers, since it can be fully controlled by the program.

Rather than having a mechanical counter, this recorder's counter is simply a switch which generates an electrical pulse as the tape reel turns. These pulses are kept track of by the 6301 which does I/O control. The tape count can be displayed at any time by the TAPCNT command in Basic.

The advantage of this arrangement is that the program always knows where the tape is positioned. Basic has a WIND command which can be used to either completely rewind the tape, or else to wind the tape to any specific spot on the tape. In this way it is possible to accurately place program or data files on the tape under fully automatic control.

Finally, the HX-20 has several connectors around its sides. There is a bus connector on the left side for the addition of major I/O devices. On the back there are two DIN connectors, one for RS-232C devices such as a modem or printer, the other a high-speed serial connector for a floppy disk controller or CRT interface (both of which have been promised, but not yet released). On the right side are three small connectors for an external cassette recorder and a bar code reader.

It is interesting to compare the I/O devices with those of the Radio Shack Model 100, a newer and probably much more popular machine. The Model 100 also has a full keyboard and LCD display, but its display has 8 lines instead of 4, and 40 characters per line rather than 20. The Model 100 characters also appear larger, and thus not as clearly defined.

In many applications, especially text processing, the larger LCD display of the Model 100 is noticeably better. In fact, the small display of the Epson is a serious drawback. On the other hand, I've done some text editing on the one-line display of the Radio Shack pocket computer, so I would say that it is quite possible to do respectable work on the four-line display of the Epson as well.

By having a smaller display, the Epson also has room for both a printer and the microcassette recorder, which the Model 100 lacks. Regardless of how easy or difficult it is to edit text, it is always useful to be able to get a printed listing, and (in my mind) essential to get it stored on some mass storage device before you accidentally clobber it. While a printer and cassette recorder can be connected to the Model 100, it is obviously much more awkward to carry three boxes than to carry just one.

The Model 100, on the other hand, has a built-in direct connect modem. Several writers in other magazines have indicated that they like to do their text editing on the Model 100, and as soon as memory is full they then upload it to Compuserve or the Source, or perhaps their office computer via a phone. Except for the cost that seems like a good idea, unless you are in a place where there either is no phone, or where the phone does not have a modular jack for connection of the Model 100. That pretty much lets out pay phones and most hotel room

telephones.

The alternative, of course, is to carry an acoustic coupler. Doing that puts the Model 100 and the Epson on an almost equal footing, since you must then carry another I/O device. (I say "almost equal" because the Epson's CX-20 coupler is a more expensive option than the Model 100's coupler.) Granted that the Model 100's acoustic coupler is smaller than Epson's, I am really impressed by the Epson coupler. It is the only battery-operated coupler I know of, quite small and neat, and very well designed. It can be used in both originate and answer modes, and has a test mode as well. In fact, I am surprised that Epson has not aggressively marketed the coupler all by itself - I am sure that many owners of other computers would love to buy the Epson CX-20 coupler even though they don't have the HX-20 computer. (In fact, the CX-20 coupler may be more useful on other computers, since it is not furnished with any software for the HX-20. You would have to write your own program if you wanted to upload text files from the HX-20 to another computer.)

Software

While on the subject of comparing the HX-20 with the Radio Shack Model 100, it is interesting to compare them from the software standpoint as well.

Both computers have a Microsoft Basic interpreter; though I have not compared them directly, I would suspect that they are both fairly similar. The Model 100, however, has several other user programs in ROM, including a telecommunications program which makes use of the built-in modem, a scheduler and address organizer, and a word processing program. The Epson, on the other hand, contains only its SkiWriter word processor program. (SkiWriter is fairly new, and earlier HX-20 computers were not equipped with it. Only recently has it been supplied as part of the computer.) The HX-20 that I used did not have the SkiWriter ROM and so I am not able to describe it; however, a reviewer writing in the September 1983 issue of MICROCOMPUTING seemed preferred the SkiWriter to the Model 100 word processor.

Whenever you turn on the computer, or whenever you press the MENU button, the LCD displays a menu with up to eight choices. The first three choices are Basic, a monitor, and (on machines so equipped) the SkiWriter editor; the remaining five choices can be Basic programs residing in RAM. You type a number from 1 to 8 to make a choice, and immediately go to the requested program.

Basic program memory can be partitioned to hold five separate programs. This memory division is dynamic, and each program gets only as much space as it needs, up to the total RAM limit available. You move from one program partition to another by a LOGIN command; assigning a TITLE to a program locks it in memory (so it cannot be accidentally erased), and puts the title in the menu.

In addition, memory can also be assigned for data storage using "RAM files". A RAM file is an area of memory that is accessed in the same way as a serial storage device which can be read or written. Unlike program variables, data in a RAM file does not get erased when you change to another program or when the computer is shut off. Hence RAM file data is more permanent, and can be shared by different programs in memory.

The Basic interpreter itself is written by Microsoft, and has quite a few special extensions which make the HX-20 quite powerful. In addition to the standard Basic features, this Basic also has the following extra statements:

CDBL, CINT and CSNG for conversions to and from integer, real, and double precision numbers
DEFFIL, GET4 and PUT4 statements for RAM files
AUTO line numbering
COPY for dumping screen data to the printer
ERASE for erasing arrays
ON ERROR GOTO, ERL and ERR recovering from errors
ERROR statement for simulating an error condition for testing
FILES for showing the contents of files
FRE for checking the amount of free memory
HEX$ and OCT$ functions for hexadecimal and octal numbers
Several forms of INPUT for inputting files etc.
KEY and KEYLIST for defining and reading special function keys
LINE, PSET etc. for screen graphics
LIST for listing to devices other than screen
LOF for checking the size of a file or buffer
MON for going to the monitor
RENUM for program renumbering
RESTORE for rereading DATA statements
WIND and TAPCNT for controlling the micro cassette
TITLE and LOGIN for switching program areas
TIME$, DATE$, and DAY for reading and setting the time of day clock
WIDTH for setting the size of the virtual screen
SOUND for controlling the piezoelectric speaker.

CONCLUSIONS

All in all, the HX-20 is a quite powerful little computer, one which shows that a lot of thought went into its design. Some of its features are quite unusual for such a small machine. For example, the keyboard has a type-ahead buffer which seems to be about 8 characters long. The piezoelectric speaker is controlled by the I/O processor, so that sound generation can be overlapped with processing. The function keys are very handy and powerful. The time of day clock can be put to a lot of good use. Above all, the presence of the built-in printer and microcassette recorder gives the computer a lot of flexibility and power it would not otherwise have.

Yet the machine has a few drawbacks which may appear serious to some. My main objection is the keyboard. Although it is full-size and looks beautiful, I find that the keys stick. I simply cannot use it at the speeds I am accustomed to. Since my main use for a computer of this type is for word processing, that rules out the HX-20 as far as I am concerned. (Considering that I have used even a Radio Shack pocket computer for text processing, my not being able to live with the Epson keyboard is not because I am picky.)

My second reservation about the HX-20 is due to the lack of software. I believe that is being currently remedied, and the availability of the SkiWriter editor is certainly an improvement. But when I first got the HX-20, the only thing you could do was to run Basic. Although I received the CX-20 acoustic coupler for testing, there was no useful software for it except for a nine-line Basic program which I accidentally found on page 390 of the manual as an example of using the LOF function.

On the other hand, the mere fact that it was on page 390 is a good sign - the documentation supplied with the computer adds up to somewhere around 700 pages, and consists of an operations manual, a Basic tutorial manual, a Basic reference manual, and a microcassette manual. Sorely needed is the technical reference manual, which would hopefully provide information on the actual programming of those 6301 processors. Remember those? That's how we got interested in the HX-20 in the first place.

ACORN

MOTHER BOARD

REVIEW

Bare Board: $64.95
Kit: $149.95
Assembled: $199.95

Why a new mother board? First, a little history. When I first got interested in computing, it was the early days. I purchased a SWTPC 6800 computer system. It came with a MP-B motherboard, a MP-A 6800 processor card (with Mikbug) and a 4k memory board with 2K supplied. The memory card was expandable by another 2K for only $125. The whole system, at the time, cost $395. I also purchased a CT-1024 terminal and a AC-30 cassette interface.

After much expansion and changes, the system grew to use a 6809 MP-09 processor card, dual 5" disk drives with a DC-2 controller, 64K of memory, DMAF2 controller with 8" drives and numerous peripherals such as MP-LA parallel cards for my 2 printers and the MP-T interrupt controller, and MP-R eprom burner. I am still using a PR-40 printer which I have had for many years. It still performs well and I use it often particularly for catalog listings of my disks. The only problem here is ribbons, which have become more or less obsolete.

In this system, the mother board had been replaced by a MP-B2 SWTPC unit. Recently I added 2K of 6116 ram to the processor card for the purpose of running several small utilities as "resident". This means that the utilities are loaded into the ram by a startup file and afterwards do not have to be loaded from the disk each time you call them. They execute instantly when loaded this way. The program for this is available (public domain) from the Southern New England Flex User Group. There was, however, one problem with this approach. The ports on the MP-B2 motherboard were not fully decoded and the ports were reflected in the ram location. Out came back issues of the Micro Journal. I remembered seeing an article on fully decoding the motherboard port addresses. I found the article and modified the motherboard. This produced a kludge which looked terrible and appeared fragile as I had to solder chips onto other chips with their pins up in the air and drill the board to pass wire wrap wire underneath. Although it worked, replacing boards in the MP-B2 was a little chilling. Also my SWTPC version of FLEX would now configure for 16 bytes per port rather than the actual 4 bytes that was correct. At first I was confused and though I had made an error wiring the decoders as I could not address my printer in port seven. The SWTPC utility "SBOX" showed "10=16" and I realized the error. Using "SBOX" in a startup file cured this also.

Experiments with FLEX and other operating systems soon proved that the older motherboard had exceeded its usefulness. The limitations that I encountered in my Quest for expansion were numerous. In order to use extended addressing, the MC-14411 baud rate generator had to be removed from the processor card as the SS-50 baud rate lines were used to generate the extended addresses. The limitations of the port addressing meant that (with 2 printers and a MP-T timer) I could accommodate 5 serial ports at the most. After considering the alternatives, a newer motherboard seemed like the best idea. Unfortunately SWTPC no longer offers the chassis, motherboard and MP-ID card separately. (Even so, I estimated the cost of this conversion at over $600.) I could get a baud rate generator for the back plane and cut the traces on the old motherboard, but this solution again reduced the number of serial ports to 4 and involved more motherboard modifications.

About this time I was introduced to Merle and Ross of Acorn Computer Systems, 11931 W. Bluemound Road in Wauwatosa, Wisconsin, a suburb of Milwaukee (Phone: 414-257-0300). I purchased a PB4 intelligent port buffer from them and replaced one MP-LA parallel port with it. The thing was very well thought out and well made. It exceeded my expectations. With this device, the FLEX print spooler actually became usable. Previously, the spooler would hang so much during disk accesses as to be useless. The buffer allowed very quick disk access and the process was almost transparent - a 1000% improvement.

Well, the folks at ACS were working on the motherboard at that time and had just gotten some into stock. They had designed and laid out the whole board themselves. I was impressed with the thickness of the glass as well as the quality of the copper and plating. The board was about twice the thickness of the MP-B2 and had the extended address lines of the SS-50 bus freed from the baud rates. The baud rate generator was still a MC-14411, but it was now on the motherboard, attached and buffered into the SS-30 lines only. Also their selection of rates matched the basic rates used by SWTPC on the newer motherboards they were using in the S09 and S+ systems. The baud rates available are 110, 300, 1200, 4800 and 9600. The 300 and 1200 rates I use for modem communications and the 9600 is used for the main terminal on the system.

Merle and Ross let me build my own board, but they did teach me a technique f assembling that they are using when they are selling boards "factory" wired. If you are in the market for a new motherboard, you may want to consider buying an assembled unit from them, as they will assemble it using this technique. First of all, they are using SQUARE molex pins rather than the round ones usually found in the older motherboards. These make much better board contact. I have shown the motherboard to several people and they have all been impressed with the positive contact these pins afford. The magic of ACS's method lies however, in using 2 motherboards together to assemble the pins into the various slots. They place the pins into one of the boards and use another one to force a perfect alignment before soldering. When the board has been soldered, and the other board removed, the pins are almost perfectly aligned. It is remarkable to see all the cards standing straight up for the first time. Most of my cards had a slight list to them when installed in the older motherboard (alas, my Motorola-SWTPC 64K memory card, which was cut too long at the bottom, making the molex receptacles stretch, still leans forward).

Another advantage to this motherboard, which really was a design effort on ACS's part to accommodate their NMI switch on the left side of their computer system, is that the first slot of the SS-50 slots is offset to the right. Anyone using an older SWTPC mainframe with a DMAF2 disk controller knows that the left edge of the card ends up forced into the chassis brace of the mainframe. You either learn to live with this or cut out the brace which decreases the rigidity of the structure. The DMAF2 card, used in this first slot will now almost perfectly align with the other cards on the right edge allowing a perfect fit.

ACS also showed me a very clever mounting method that they are using in their own main frames. Years ago, I decided the the SWTPC supplied molex board supports were unsatisfactory. Removing a card from the bus almost always entails pulling the motherboard out of the chassis and sometimes breakage of the supports. I had decided to use screws and spacers under the board with nuts above the board to permanently mount the motherboard in the chassis. This worked much better than the factory molex supports as you could now remove and replace cards easily. ACS uses a similar method, but, the have 6-32 x 3/4 screws installed in the chassis and (clever) a spacer which is hex shaped and threaded. You install the screws from the bottom, use the spacers to permanently mount the assembly into the chassis, place the mother board on top and use another set of these spacers to retain the motherboard. Since they are hex shaped, the are easily removed and installed by a simple 1/4 inch nut driver. The areas where these supports are on the motherboard are all ground plane and the solder mask does not cover these areas so that the chassis is well grounded to the motherboard. The DMAF 2 card and disk connector were also too tall to allow the use of the cover properly with the older motherboard. This fault is also corrected using the ACS mounting system.

The board is very well solder masked, and as a result easily assembled. The plated throughs are among the best. I still tend to fill plated throughs with solder to reduce tension on boards when they are removed and replaced. Plated throughs on memory cards bother me especially.

The particulars on this board are: .093" thick glass epoxy board with 2oz copper and all feed-throughs plated, 8 - SS-50 pin slots, 8 - SS-30 pin slots, Baud rate generator on board. The baud rate generator is buffered by a 74L04 bef e going to the buss. All logic power on the mother board is supplied by a 7805 regulator. The data buss is driven by a 74LS640. 16-byte port address decoding is switch selected on any 128 byte boundry from $8000 to $F000. The decoding for this is supplied by a 74LS138 and a 74LS32. Individual ports in this space are decoded by another 74LS138. A0-A3 are

sent to the IO by a 74LS367 or 8T97 buffer. There are also several spare gates on board. A 74LS368 buffers RST, R/W, and E. The IRQ and FIRQ lines have 10k pullups installed. All of the chip locations on the board are clearly marked for the chip name (not things like "U1" or "U2" but the actual name of the chip like "74LS138") and the pin one locations have a dot to indicate their direction.
The 50 pin buss also has 3 spare lines on either side of the 50 pin lines, for a total of 6 extra user-defined lines. These are very handy for battery backup cards for one thing. These six lines are brought to the rear of the card, near the seventh slot of the 30 pin buss, this area can be used for termination, breadboarding, etc. These six lines have been pre-defined on the motherboard as "x1, bat, x2" on the right and "x3, x4, x5" on the left side. The front of the motherboard has power, ground and reset hookups similar to the ones found on the older motherboards and I made up a harness exactly like the one on the original motherboard for plugging into the power supply molex connectors. This even allows me to change the motherboards quickly if I want. The rear of the ACS motherboard has a series of connections intended for use in the ACS "stacking" computer. ACS refers to this as a "VP-20" buss. The buss has the 8-volt, +16-volt, -16-volt and ground connections, as well as the 6 user-defined lines with the "bat" connections all set up for battery backup. The 30 pin buss is brought out to this buss with 18 lines plus one user-defined line, for easy expansion of the IO section. There are also two "D" lines left spare.

Each port will decode 16 address so you can use cards with multiple IO ports. Hazelwood offers a 6850 4-port card. SWTPC also has a 4-port serial card but it runs a different ACIA and must be programmed differently that the 6850. AAA, of Chicago, is offering a 2 - port serial card. Older MP-S cards from SWTPC will work but show up as four cards in one slot. This means that $E000, $E004, $E008, $E00C are all the same card. The MP-S could be modified to give only one address decode, but why? It still is one port taking up a 4-port address space, just be careful when programming. Incidentally, UniFLEX uses $E000 for output, FLEX uses $E004 and OS-9 uses $E004, if you could run all three on the same system, you would never have to move an MP-S card around (a dubious advantage).

The motherboard was fitted into my old SWTPC chassis (which STILL says "6800" on the front), and fits perfectly in that space. I am not sure, but I don't know of another motherboard, which has the same amount of board and port space, that isn't larger than the old chassis. The new motherboard, like the PB4 port buffer has exceeded my expectations. Yes, you can get cheaper boards but, the quality construction of these units and the careful design and execution are worth the extra. This unit is being used in our facilities for both demonstration of operating systems and for repair convenience. I can pull the processor card and the DMAF2 card out and switch rapidy between FLEX and OS-9. We are also using this mainframe to test and burn-in memory cards. This also involves removing and replacing cards quite often. This motherboard, with its square pins and extreme rigidity has supplied an ideal tool for us. I rate it AAA.

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CCSM STANDARD MUMPS REVIEW

The version of ANSI standard MUMPS written by Computer Consultants for the 6809 is an interpreted language packaged with special multi-tasking operating system, and a set of utility programs. The language is not very good for elegant structured programming, but it uses an unusually useful file structure.

MUMPS (Massachusetts General Hospital's Utility MultiProgramming System) was developed by the Laboratory of Computer Science at Massachusetts General Hospital. The design goal was an interactive language running in a time-shared environment on a minicomputer that had strong support for text strings in its file system. Development started in 1967, and must have been finished within a few years because in 1972 there were at least fourteen different versions of the language. The ANSI standard definition of MUMPS was accepted in 1977. There is a new standard for MUMPS in the works, which CCSM MUMPS implements.

Some versions of MUMPS run under a normal operating system, but CCSM MUMPS comas integrated with its own operating system. It cannot be run under OS-9 or FLEX, nor can any FLEX or OS-9 program be run under the M MPS operating system. This is not as bad as it sounds. It is very much like being stuck in a version of BASIC with lots of BASIC utilities available.

The MUMPS File System

The foundation which CCSM MUMPS is built on is a B-Tree file system. A B-Tree is the most highly regarded way to index data on a disk. In MUMPS, data files, programs, and temporary storage are all stored in this efficient structure, but appear to be in memory. The programmer never has to think about reading or writing the disk. Data files are called global variables. A MUMPS program may believe that the computer has a tremendous memory even if there is only 56K of real memory. The system is essentially using the same virtual memory tricks used in larger systems. MUMPS files are manipulated as if they were a strange type of array. It is, for example, valid to say:

SET ^A(1,1) = ^A(1,15) where ^A denotes a global variable. To do the same thing in a more conventional language would require at least a explicit read and write.

The new (not yet standard) level of MUMPS, allows subscripts to be strings instead of just numbers. This makes statements like:

SET ^LIB(Peter,gender) = "Male" possible. The B-Tree structure makes it possible to find the member of the array (file) with subscripts of "Peter", "gender" in a reasonably short time. It is also possible to expand the data file with no particular effort. I could add ^LIB(Peter,PlantCount) to the file by just assigning it a value.

MUMPS stores all information on disk as variable length strings. This wastes a little space, but makes the disk structure of the file independent of the lengths of fields. Programmers using MUMPS are most likely not at all worried about the new longer zip code. If a program doesn't check for validity of the zip code field by insisting on five numeric characters, the field can be lengthened without programmer intervention.

The MUMPS Language

It is futile to try to explain an entire language in one short review, especially when there is an operating system to talk about as well. MUMPS is a language which is easy to learn superficially, but full of subtle ways to do things which give a surprising amount of depth. I learned it just well enough to determine that the CCSM implementation

works, and to pick up the flavor of the language. The standard MUMPS commands are:

BREAK -- Await a signal
CLOSE -- Release a device
DO -- Like Call or Gosub (no arguments)
ELSE -- Usual meaning
FOR -- Much extended from the familiar FOR
GOTO -- Just what you expect
HALT -- Terminate current process
HANG -- Pause for a number of seconds
IF -- Does the usual stuff. Only controls one line
KILL -- Free storage allocated to variables
LOCK -- Lock, or unlock a resource.
OPEN -- Obtain exclusive ownership of a device
QUIT -- Define exit point for FOR, DO, or EXECUTE
READ -- Input from the current device
SET -- needed for assignment statements
USE -- designate the "current device"
VIEW -- implementation dependent
WRITE -- Output to the current device.
XECUTE -- interpret and execute arguments
Z -- extensions to the standard

The standard MUMPS functions are:

$ASCII -- Takes the ORD of one character in a string
$CHAR -- Translates a series of integers to characters
$DATA -- Finds out if a variable is defined
$EXTRACT -- A typical Substring function
$FIND -- Return the position of a substring in a string
$JUSTIFY -- Right Justify a string or number
$LENGTH -- Return the number of characters in a string
$NEXT -- Value of the next subscript in an array
$PIECE -- Picks a substring out from between two delimiting substrings.
$RANDOM -- Generate a random number
$SELECT -- Evaluates a series of pairs of expressions. The first in each pair is evaluated for a boolean true/false. When the first true value is found, the function ends and returns the value of the second expression in that pair.
$TEXT -- Returns the text of a line of code.
$VIEW -- Implementation-specific
$Z_ -- Non-standard functions start with $Z

A powerful feature of MUMPS that isn't evident from the list of commands is the pattern match-string operator. The expression VAR?pattern is true if the value of VAR matches the pattern -- VAR'?pattern is true if VAR doesn't match. The pattern can contain specific strings that must be matched, and general specifications:

A -- Matches Alphabetics
C -- Matches control characters
E -- Matches everything
L -- Matches lower case alphabetics
N -- Matches numerics
P -- Matches punctuation
U -- Matches upper case alphabetics The number of times a specification should be matched (called the multiplier) is placed before the specification. For example, 1P5A1"." would match a string that consisted of a punctuation mark, followed by five alphabetic characters, followed by a period. If you want to match any number of something, a period can be used as the multiplier. Specifications can be concatenated (AP would match alphabetics and punctuation).

The extensions to the ANSI standard implemented in CCSM MUMPS are:

The JOB command, which starts a new task, and the $ORDER function which works about like $NEXT, but is intended to replace it.

The $VIEW function is used to examine real memory. The VIEW command is used to change bytes in memory. Two of the Z commands are especially interesting: ZONLINE connects the terminal to a specified device. This is intended to allow the terminal to be attached to a modem. ZXECUTE lets a MUMPS program execute assembly language routines.

CCSM MUMPS Utilities

CCSM MUMPS comes with a set of utility programs. Since MUMPS is a widespread language with a mature base of users (some of them very large), there are sources for MUMPS programs, including more utilities.

The full screen editor utility only works if you have just the right hardware. I don't.

There is an online help utility called ZH which prints help lines from programs, or sections from the online help manual.

The ZI utility is a great help in finding a missing routine. It lists the first three lines in each file that matches a given search criterion.

The ZP command is a directory command. It gives a list of the files on the current device.

The ZZ command is a line editor. It is about like most other medium good line editors.

There are a family of utilities available from a special menu. The are:

Edit groups of routines
List routines by groups
Copy routines across drive
Kill routines
Change/search for strings in routines
List global structures (data files) and contents
Copy globals
Pack a structure (group of files)
Print Diskette name and volume number
Change diskette name and volume number
Copy Diskette
Reset time and date
Copy MUMPS OS
Format new diskette
Print free blocks

Sample of MUMPS programming

David Brown was kind enough to let me print one of the sample programs from a book on MUMPS that has written (Cookbook of MUMPS published by Eclectic Systems). I considered expanding the program from the compressed form that he (like most MUMPS programmers) writes in, but I think the program makes the point that MUMPS is a very compact and powerful language best as it stands.

There are a few additional facts about MUMPS that will help the most determined readers read this program. All MUMPS commands can be abbreviated to the minimum length that is unambiguous. For example, WRITE can be abbreviated W, and IF can be written I. In a WRITE statement "!" means skip to the next line. A carat "^" before a variable name means the the variable is global. More than one command can be placed on a line. Finally, if a command is followed by a colon and a boolean expression (Q:X="") the command will be executed if the boolean value is true.

The following program presents a menu giving a choice of initializing a list of names, adding names to the list, or printing the list. If you decide to enter names, it will prompt for a name; make certain that it has valid form and that it is not already in the name file; and add it to the file. Since the file is kept in a B-Tree structure, the file can be read randomly by the index value, name, or sequentially using the $ORDER function. B-Tree files are inherently sorted, so the file will be printed out in sorted order by just running through the file using $ORDER.

```
LISTT ; DBB,,,BOOK;7MAYB2 2:32PM;ALPHA LIST EXAMPLE;
LIST  W !!,"OPTION:",!!
      W "1.INITIALIZE",!,"2. ENTER NAMES",!,
         "3. PRINT LIST",!!
      R ?5,":",OPT,!,! OPT="" K OPT,X Q
      I OPT'?1N!(OPT<1)!(OPT>3) W *7,"PLEASE CHOOSE 1-3",
         ! G LIST
      D INIT:OPT=1,ENTER:OPT=2,PRINT:OPT=3 G LIST
INIT  S X="Y" I $D(^ALPHA) W *7,"ARE YOU SURE ? " R X,!
      I $E(X)="Y" K ^ALPHA
      E W "NOT "
      W "INITIALIZED !!",! Q
ENTER R "NAME (LAST,FIRST MI):",X,! Q:X=""
      I X'?1A.AI","1A.AP W *7,"  BAD FORMAT",! G ENTER
      I $D(^ALPHA(X)) W *7," THIS NAME ALREADY EXISTS",!
         G ENTER
      S ^ALPHA(X) = "" G ENTER
PRINT W @!! S X=""
PRNT2 S X=$O(^ALPHA(X)) Q:X=""
      W X,! G PRNT2
```

Limitations

The MUMPS language is hard to criticize. For what it is, it is very good. It doesn't have enough restrictions to make a good structured programming language, and there is no way to pass parameters to procedures when they are called. I am fascinated by MUMPS, but I don't approve of it.

For many business applications, particularly simple database problems, MUMPS would be excellent, but for other types of processing it would be very poor. MUMPS may be the worst language I know for scientific calculations. It is interpreted, therefore slow, and is missing all the predefined mathematical functions one might want.

The worst problem with CCSM MUMPS is that it is more than just a language. As an operating system, it is too limiting. I had to reconfigure my hardware every time I wanted to test MUMPS, chiefly because it can only deal with five and a quarter inch floppy disk drives and hard disks -- I have my hardware configured to boot off of an eight inch drive. There isn't a documented way for me to add a new device driver to the system, or even an assembler to write the driver in. With the right hardware, it should be possible to make MUMPS the alternate operating system in a GIMIX software switching system. If I didn't have to run FLEX every few months, I might make MUMPS into my second system, and live with a five and a quarter inch system drive.

Summary

I have seen MUMPS running on a DEC and a Data General minicomputer. I don't know how well MUMPS ran on those machines, but both were running commercial programs of which simple database operations were an important part. Both versions of MUMPS were said to be ANSI Standard. There is a lot to be said for using a standard language, particularly when you are using a small computer. When you outgrow your 6809, you can move on to a larger computer without having to rewrite your software.

It is a tremendous advantage to be able to write programs without having to worry about memory. In MUMPS the entire disk appears to be available memory, i.e., there is no need to ever think about memory. The system keeps the most recently referenced pages of memory in main memory, and writes less recently referenced pages out to disk if it needs to find space for a new page from disk. This is the principle behind virtual memory, which is usually implemented in hardware. MUMPS, being an interpreter, doesn't have to rely on hardware to do its paging.

The CCSM MUMPS operating system knows about the DAT on the CPU boards it supports. It uses the DAT to get at all of the memory in the computer with equal ease, not just some selected 64K.

If I could run MUMPS under OS-9, I would frequently find uses for it. There are many times when its slow speed would not hurt, and its simple string handling and database system would be great advantage. Recently I thought of suggesting MUMPS as the best language to write the software for a system that interacts with id-card readers, and opens doors when an authorized card is read. The software for that system would probably have been written more quickly, and be more functional, if it were written in MUMPS.

I am not going to switch from OS-9 to MUMPS. I stopped writing business software years ago, and, as I see it, that is the environment where MUMPS would be of the most use. I will, however, keep the manuals available. I have many friends who frequently have to solve problems that MUMPS would whiz right through.

By: Peter Dibble

CONVERTING FLEX to OS-9

The Conversion of Assembler-Language Motorola 6809 Application Programs from the FLEX Operating System to the OS/9 Operating System

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INTRODUCTION

This article provides a set of guidelines, procedures, and concepts for the specific purpose of the conversion of assembler-language application programs written for the FLEX operating system to operate under control of the OS/9 operating system.

This article does not provide a comparison of the relative powers or flexibilities of the two systems, but suggests how to use the facilities of OS/9 for the purpose of performing essentially all of the facilities of FLEX. It features the power of OS/9 as applied to the task of simulating a FLEX-style program interface to OS/9.

This conversion is of interest since much current application software written for FLEX must be rewritten for OS/9 for future use, since OS/9 is becoming available on more computers, whereas the growth of FLEX has recently become far slower than that of OS/9. OS/9 and program development aids such as BASIC09, Microware C, PASCAL, COBOL, are available to assist in the development of new systems for OS/9, but older systems must be converted.

The conversion process is discussed primarily with respect to the functions of the standard FLEX entry points, storage locations, and facilities, and the corresponding OS/9 system requests and facilities. Physical media conversion is also discussed.

The additional attributes required of OS/9 programs, such as module organization and position-independance, are also discussed, as is efficient use of OS/9 system calls and facilities.

This article does not specifically provide a tutorial discussion of FLEX, OS/9, and their corresponding assemblers. Reference manuals describing each of these products may be obtained from their manufacturers.

However, since there is no good single defining document for all of the FLEX entry points, storage locations, and facilities, this article presents definitions for all such external FLEX attributes and their relation to application programs currently intended to run under the FLEX operating system.

The restriction to application programs is intended to exclude programs (such as printer drivers) which are intimately related to the FLEX system itself, and must therefore be essentially rewritten to convert their function to another operating system.

A second article in this series will discuss the conversion of UniFLEX programs to OS/9.

OS/9 BACKGROUND

The OS/9 operating system is one of several products of **Microware Systems Corp.**

It is actually a generic name for two operating systems for computer systems based upon the Motorola 6809 microprocessor. Both versions support multi-user and multi-tasking access. Version 1 of OS/9 supports up to 64K bytes of main memory, whereas version 2 supports up to 1M bytes of main memory.

A smaller amount of application software is currently available for OS/9 than is available for FLEX, although more is becoming available.

OS/9's primary advantages over FLEX lie in the areas of security, multi-access, expandability, and ease of interfacing to new devices requiring complex processing. OS/9 is almost totally interrupt driven.

OS/9 supports a file security system providing for basic control of file and directory access and update. However, assembler language programs may circumvent the security system (with some amount of difficulty).

FLEX BACKGROUND

The FLEX operating system is one of several products of **Technical Systems Consultants, Inc.** Another is UniFLEX, discussed later in this series of articles.

At one time, it was the most popular operating system for systems based upon the Motorola 6800, and then the 6809, microprocessors. It is simple to use, inexpensive, reliable, and supports single user access quite well. It supports 64K bytes of main memory directly.

Because of its past and current popularity, a large amount of application software has been written for systems using FLEX.

FLEX supports interrupt handling directly only to the extent that interrupts are used in the printer spooling logic. However, it does not prohibit programs running under its control from supporting interrupt processing themselves, as long as the interrupt processing routines do not conflict with each other.

FLEX provides a rudimentary form of file security for file and catalog access and update. However, assembler language programs may circumvent the security system fairly readily.

OS/9 COMMAND LINE

The OS/9 command line is formatted as follows:

```
command [p1...[pn] [<si] [>so] [>>eo] [|pipe] [&] [;...]
```

where: command is the name of the program to be executed,
p1...pn are command parameters,
<si is a redirected standard input path,
>so is a redirected standard output path,
>>eo is a redirected standard error output path,
|pipe is an indicator specifying pipeline processing,
& is an indicator specifying background processing,
[;...] is multiple commands, executed left to right.

In addition, OS/9 supports the user entry of CNTL-C to kill the current task running from the terminal and of CTRL-A to repeat the last line of input from the terminal, for further editing.

FLEX COMMAND LINE

The FLEX command line has the following format:

```
[c1]...[cn] command [p1]...[pn] [;...]
```

where: c1-cn are pre-commands (such as printer drivers, etc.),
command is the name of the program to be executed,
p1-pn are command parameters,
[;...] is multiple commands, executed left to right.

OS/9 PATH NAMES

An OS/9 path name has the following format:

```
[/dir1/../dirn/]name
```

where: /dir1/../dirn/ is the specification of the path,
name is a 1-29 character file name, starting with a letter,

Program files default to the execution path (set by the "chx" command) and data files default to the data path (set by the "chd" command).

FLEX FILE NAMES

A FLEX file name has the following format:

```
[drive.]name[.suffix]
```

where: drive is drive number 0-3;
name is a 1-8 character file name, starting with a letter,
suffix is a 1-3 character suffix.

Program files default to the system drive and data files default to the work drive (both set by the "asn" utility command).

OS/9 PROGRAM INTERFACE SUMMARY

Every OS/9 application program is composed of one or more OS/9 modules. An OS/9 module is known to the system by possessing a property-formatted module header and trailer, both of which are described later in this article.

Application programs request services from OS/9 in the following simple manner: each request is a system call (specifically, swi2), followed by a one-byte parameter, of the following symbolic format:

```
os9 code
```

where "code" represents one of the standard OS/9 system call numbers. The OS/9 assemblers translate this symbolic format into the equivalent of the following object code:

```
swi2
fcb   code
```

Parameters are passed in registers and in memory areas referenced by the registers between the application modules and OS/9 and vice versa. Application programs may not normally inspect or modify OS/9 storage. Under OS/9 version 2, application programs may not inspect or modify memory locations associated with other users of OS/9, since they are not in the addressable memory space.

OS/9 may be easily configured to support at least the following devices, depending upon the implementation:

- 5.25" floppy disks,
- 8" floppy disks,
- hard disks,
- console display,
- console keyboard,
- serial printer,
- parallel printer,
- specialty printers,
- etc.

Files intended for the console may be redirected to any other device. Other devices may be directly supported by application programs on OS/9 Level 1, or by device drivers on OS/9 Level 1 or 2. Device drivers are usually provided for a subset of the devices listed above. Some device parameters, such as the echo flag for the console keyboard, may be modified easily in a device descriptor associated with each device.

Files for all devices are handled in a very similar manner by OS/9. The I/O subsystem is invoked thru a subset of the OS/9 system calls. All disk files are accessable sequentially and randomly, and no distinction is made between files containing binary (arbitrary) data and text (printable) data; all disk files may contain arbitrary contents. The logical block size on disk and similar devices is 256 bytes.

An application program may create additional tasks and specify that they are to run in asynchronous, synchronous, or pipelined mode, and, in the latter two modes, monitor their progress and completion status.

Since modules for OS/9 must be written to use pure position-independant code, they may be loaded as required in the logical address space, and multiple users of the same module share the same code, although each user has an independent data address space. Programs must be loaded into contiguous memory addresses, but OS/9 handles the memory allocation.

FLEX PROGRAM INTERFACE SUMMARY

Application programs request services from FLEX in a simple manner: each request is a jump to subroutine (JSR), of the following format:

```
jsr entry
```

where "entry" represents one of the standard FLEX entry point vectors. Parameters are passed in registers and in memory areas between the application modules and FLEX and vice versa. Application programs may inspect and change FLEX storage locations directly.

FLEX (or, specifically, SWTPC FLEX) directly supports the following devices:

- 5.25" floppy disks,
- 8" floppy disks,
- hard disks,
- console display,
- console keyboard,
- serial printer,
- parallel printer,
- specialty printers,
- etc.

Only four disk drives may be addressed simultaneously, regardless of type. Files intended for the console may be redirected to disk or printer. Other devices may be directly supported by application programs.

The disk file management system (FMS) is simple to invoke by an application program, utilizing a file control block (FCB) for essentially all disk file-related program-FLEX coordination. The FCB sector buffer (and physical disk sector) length is 256 bytes in length and the FCB prefix length is 64 bytes in length, making the total FCB 320 bytes in length.

When a program invokes one of the FMS entry point vectors and passes parameters to it thru an FCB, FMS returns an error indicator in a register and an error code in the FCB. FMS implements both random and sequential files, although they do not have interchangeable access, and both binary files (with arbitrary contents) and text files (with compressed spaces and suppressed control characters).

An application program may call FLEX as a subroutine, passing it a command line, and thus execute another program in a synchronous manner (as long as the memory spaces do not conflict), and receive back a limited amount of information in terms of an FMS return code.

A given application program is always loaded into the same areas of memory, even though it may in reality be position-independent. A program may be loaded into contiguous or discontiguous memory addresses, and handles its own memory allocation.

OS/9 FACILITIES

The OS/9 system and I/O request codes (used in "os9 code" assembler-language statements) are as follows:

OS/9 System Service Request Codes

Code	Name	Description
$00	F$Link	Link to Module
$01	F$Load	Load Module from File
$02	F$UnLink	Unlink Module
$03	F$Fork	Start New Process
$04	F$Wait	Wait for Child Process to Die
$05	F$Chain	Chain Process to New Module
$06	F$Exit	Terminate Process
$07	F$Mem	Set Memory Size
$08	F$Send	Send Signal to Process
$09	F$Icpt	Set Signal Intercept
$0A	F$Sleep	Suspend Process
$0B	F$SSpd	Suspend Process
$0C	F$ID	Return Process ID
$0D	F$SPrior	Set Process Priority
$0E	F$SSWI	Set Software Interrupt
$0F	F$PErr	Print Error
$10	F$PrsNam	Parse Pathlist Name
$11	F$CmpNam	Compare Two Names
$12	F$SchBit	Search Bit Map
$13	F$AllBit	Allocate in Bit Map
$14	F$DelBit	Deallocate in Bit Map
$15	F$Time	Get Current Time
$16	F$STime	Set Current Time
$17	F$CRC	Generate CRC
$18	F$GPrDsc	Get Process Descriptor Copy
$19	F$GBlkMp	Get System Block Map Copy
$1A	F$GModDr	Get Module Directory Copy
$1B	F$CpyMem	Copy External Memory
$1C	F$SUser	Set User ID number
$1D	F$UnLoad	Unlink Module by name

OS/9 System Service Reserved Request Codes

Code	Name	Description
$28	F$SRqMem	System Memory Request
$29	F$SRtMem	System Memory Return
$2A	F$IRQ	Enter IRQ Polling Table
$2B	F$IOQu	Enter I/O Queue
$2C	F$AProc	Enter Active Process Queue
$2D	F$NProc	Start Next Process
$2E	F$VModul	Validate Module
$2F	F$FInd64	Find Process/Path Descriptor
$30	F$All64	Allocate Process/Path Descriptor
$31	F$Ret64	Return Process/Path Descriptor
$32	F$SSvc	Service Request Table Initialization
$33	F$IODel	Delete I/O Module
$34	F$SLink	System Link
$35	F$Boot	Bootstrap System
$36	F$BtMem	Bootstrap Memory Request
$37	F$GProcP	Get Process Pointer
$38	F$Move	Move Data (Low Bound First)
$39	F$AllRAM	Allocate RAM Blocks
$3A	F$AllImg	Allocate Image RAM Blocks
$3B	F$DelImg	Deallocate Image RAM Blocks
$3C	F$SetImg	Set Process DAT Image
$3D	F$FreeLB	Get Free Low Block
$3E	F$FreeHB	Get Free High Block
$3F	F$AllTsk	Allocate Process Task Number
$40	F$DelTsk	Deallocate Process Task Number
$41	F$SetTsk	Set Process Task DAT registers
$42	F$ResTsk	Reserve Task Number
$43	F$RelTsk	Release Task Number
$44	F$DATLog	Convert DAT Block/Offset to Logical
$45	F$DATTmp	Make Temporary DAT Image
$46	F$LDAXY	Load A [X,[Y]]
$47	F$LDAXYP	Load A [X+,[Y]]
$48	F$LDDDXY	Load D [D+X,[Y]]
$49	F$LDABX	Load A from 0,X in Task B
$4A	F$STABX	Store A at 0,X in Task B
$4B	F$AllPrc	Allocate Process Descriptor
$4C	F$DelPrc	Deallocate Process Descriptor
$4D	F$ELink	Link using Module Directory Entry
$4E	F$FModul	Find Module Directory Entry

OS/9 I/O Service Request Codes

Code	Name	Description
$80	I$Attach	Attach I/O Device
$81	I$Detach	Detach I/O Device
$82	I$Dup	Duplicate Path
$83	I$Create	Create New File
$84	I$Open	Open Existing File
$85	I$MakDir	Make Directory File
$86	I$ChgDir	Change Default Directory
$87	I$Delete	Delete File
$88	I$Seek	Change Current Position
$89	I$Read	Read Data
$8A	I$Write	Write Data
$8B	I$ReadLn	Read Line of ASCII Data
$8C	I$WritLn	Write Line of ASCII Data
$8D	I$GetStt	Get Path Status
$8E	I$SetStt	Set Path Status
$8F	I$Close	Close Path
$90	I$DeletX	Delete from Current Execution Directory

The OS/9 system and I/O request return codes (returned in the B register by OS/9 system routines) are as follows:

OS/9 Error Return Codes

Code	Name	Description
$00	--------	No Error
$C8	E$PthFul	Path Table Full
$C9	E$BPNum	Bad Path Number
$CA	E$Poll	Polling Table Full
$CB	E$BMode	Bad Mode
$CC	E$DevOvf	Device Table Overflow
$CD	E$BMID	Bad Module ID
$CE	E$DirFul	Module Directory Full
$CF	E$MemFul	Process Memory Full
$D0	E$UnkSvc	Unknown Service Code
$D1	E$ModBsy	Module Busy
$D2	E$BPAddr	Bad Page Address
$D3	E$EOF	End of File
$D5	E$NES	Non-Existing Segment
$D6	E$FNA	File Not Accessible
$D7	E$BPNam	Bad Path Name
$D8	E$PNNF	Path Name Not Found
$D9	E$SLF	Segment List Full
$DA	E$CEF	Creating Existing File
$DB	E$IBA	Illegal Block Address
$DD	E$MNF	Module Not Found
$DF	E$DelSP	Deleting Stack Pointer Memory
$E0	E$IPrcID	Illegal Process ID
$E2	E$NoChld	No Children
$E3	E$ISWI	Illegal Swi Code
$E4	E$PrcAbt	Process Aborted
$E5	E$PrcFul	Process Table Full
$E6	E$IForkP	Illegal Fork Parameter
$E7	E$KwnMod	Known Module
$E8	E$BMCRC	Bad Module CRC
$E9	E$USigP	Unprocessed Signal Pending
$EA	E$NEMod	Non Existing Module
$EB	E$BNam	Bad Name
$EC	E$BMHP	Bad Module Header Parity
$ED	E$NoRam	No Ram Available
$EE	E$BPrcID	Bad Process ID
$EF	E$NoTask	No Available Task Number
$F0	E$Unit	Illegal Unit (Drive)
$F1	E$Sect	Bad Sector Number
$F2	E$WP	Write Protect
$F3	E$CRC	Bad Check Sum
$F4	E$Read	Read Error
$F5	E$Write	Write Error
$F6	E$NotRdy	Device Not Ready
$F7	E$Seek	Seek Error
$F8	E$Full	Media Full
$F9	E$BTyp	Bad Type (Incompatable) Media
$FA	E$DevBsy	Device Busy
$FB	E$DIDC	Disk ID Change
$FC	E$ Lock	Record Busy (Locked-Out)
$FD	E$Share	Non-Sharable File Busy
$FE	E$Deadlk	I/O Deadlock Error

The OS/9 direct page variables (accessible to application programs under OS/9 Level I) are defined as follows:

Direct Page Variables

Address	Name	Description
$20	D.FMEM	Free memory bit map pointers
$24	D.MLIM	Memory limit
$26	D.ModDir	Module directory
$2A	D.Init	Rom base address
$2C	D.SWI3	Swi3 vector
$2E	D.SWI2	Swi2 vector
$30	D.FIRQ	Firq vector
$32	D.IRQ	Irq vector
$34	D.SWI	Swi vector
$36	D.NMI	Nmi vector
$38	D.SvcIRQ	Interrupt service entry
$3A	D.Poll	Interrupt polling routine
$3C	D.UsrIRQ	User Irq routine
$3E	D.SysIRQ	System Irq routine
$40	D.UsrSvc	User service request routine
$42	D.SysSvc	System service request routine
$44	D.UsrDis	User service request dispatch table
$46	D.SysDis	System service request dispatch table
$48	D.Slice	Process time slice count
$49	D.PrcDBT	Process descriptor block address
$4B	D.Proc	Process descriptor address
$4D	D.AProcQ	Active process queue
$4F	D.WProcQ	Waiting process queue
$51	D.SProcQ	Sleeping process queue
$53	D.Time	Time (YYMMDDHHMMSSTT)
$53	D.Year	Year in century
$54	D.Month	Month in year
$55	D.Day	Day in month
$56	D.Hour	Hour in day
$57	D.Min	Minute in hour
$58	D.Sec	Second in minute
$59	D.Tick	Tick in second
$5A	D.T	Ticks per second
$5B	D.TSlice	Ticks per time-slice
$5C	D.IOML	I/O manager free memory low bound
$5E	D.IOMH	I/O manager free memory high bound
$60	D.DevTbl	Device driver table address
$62	D.PolTbl	Irq polling table address
$64	D.PthDBT	Path descriptor block table pointer
$66	D.BTLO	Bootstrap low address
$68	D.BTHI	Bootstrap high address
$6A	D.DMAReq	DMA in use flag
$6B	D.AltIRQ	Alternate Irq vector
$6D	D.KbdSta	Keyboard scanner static storage
$6F	D.DskTmr	Disk motor timer
$71	D.Clock	Address of clock tick routine

The OS/9 device and file descriptor offsets are as follows:

OS/9 Random Block Path Descriptor Format

$0A	PD.SMF	State flags
$0B	PD.CP	Current logical byte position
$0F	PD.SIZ	File size
$13	PD.SBL	Segment beginning lsn
$16	PD.SBP	Segment beginning psn
$19	PD.SSZ	Segment size
$1C	PD.DSK	Disk id
$1E	PD.DTB	Drive table ptr
$20	PD.DEV	Device type
$21	PD.DRV	Drive number
$22	PD.STP	Step rate
$23	PD.TYP	Disk device type (5", 8", other)
$24	PD.DNS	Density capability
$25	PD.CYL	Number of cylinders
$27	PD.SID	Number of surfaces
$28	PD.VFY	Verify disk writes
$29	PD.SCT	Default sectors/track
$2B	PD.TOS	Default sectors/track track zero
$2D	PD.ILV	Sector interleave offset
$2E	PD.SAS	Segment allocation size
$2F	PD.TFM	DMA transfer mode
$30	PD.Exten	Path extension for record locking
$33	PD.ATT	File attributes
$34	PD.FD	File descriptor psn
$37	PD.DFD	Directory file descriptor psn
$3A	PD.DCP	File directory entry pointer
$3E	PD.DVT	User readable device table pointer

OS/9 Random Block Path Extension Format

$00	PE.PE	PE path number
$01	PE.PDptr	Back pointer to path descriptor
$03	PE.NxFTl	Drive open-file list pointer
$05	PE.Confl	Circular file conflict list
$07	PE.Lock	Path lockout status
$08	PE.LoLck	Low locked logical address
$0C	PE.HiLck	High Locked Logical address
$10	PE.Wait	PE pointer to next locked-out PE
$12	PE.TmOut	Max ticks to wait for locked segment
$14	PE.Owner	Process ID of owner of locked segment

OS/9 Device Descriptor Format

$00	DD.TOT	Total number of sectors
$03	DD.TKS	Track size in sectors
$04	DD.MAP	Number of bytes in allocation bit map
$06	DD.BIT	Number of sectors/bit
$ 8	DD.DIR	Address of root directory file descriptor
$0B	DD.OWN	Owner
$0D	DD.Att	Attributes
$0E	DD.DSK	Disk id
$10	DD.FMT	Disk format: density/sides
$11	DD.SPT	Sectors/track
$13	DD.RES	Reserved for future use
$15	DD.SIZ	Device descriptor minimum size
$15	DD.BT	System bootstrap sector
$18	DD.BSZ	Size of system bootstrap
$1A	DD.DAT	Creation date
$1F	DD.NAM	Volume name
$3F	DD.OPT	Option area

OS/9 File Descriptor Format

$00	FD.ATT	Attributes
$01	FD.OWN	Owner
$03	FD.DAT	Date last modified
$08	FD.LNK	Link count
$09	FD.SIZ	File size
$0D	FD.Creat	Segment list extension
$10	FD.SEG	Beginning of segment list

OS/9 Directory Entry Format

$00	DIR.NM	File name
$1D	DIR.FD	File descriptor physical sector number
$20	DIR.SZ	Directory record size

OS/9 File Descriptor Offsets

$0A	PD.OV2	Output Device Table Pointer
$0C	PD.RAW	Read/Write or Rdlin/Wrlin Mode
$0D	PD.MAX	Readline High Byte Count
$0F	PD.MIN	Devices Are Mine If Clear
$10	PD.STS	Status Routine Module Address
$12	PD.STM	Reserved for Status routine
$20	PD.DEVT	Device type
$21	PD.UPC	Case (0=both, 1=upper)
$22	PD.BSO	Backsp (0=bse, 1=bse,sp,bse)
$23	PD.DLO	Delete (0=bse over line, 1=crlf)
$24	PD.EKO	Echo (0=no echo)
$25	PD.ALF	Autolf (0=no auto lf)
$26	PD.NUL	End of line null count
$27	PD.PAU	Pause (0=no end of page pause)
$28	PD.PAG	Lines per page
$29	PD.BSP	Backspace character
$2A	PD.DEL	Delete line character
$2B	PD.EOR	End of record character
$2C	PD.EOF	End of file character
$2D	PD.RPR	Reprint line character
$2E	PD.DUP	Duplicate last line character
$2F	PD.PSC	Pause character
$30	PD.INT	Keyboard interrupt character
$31	PD.QUT	Keyboard quit character
$32	PD.BSE	Backspace echo character
$33	PD.OVF	Line overflow character
$34	PD.PAR	Parity code
$35	PD.BAU	ACIA Baud rate for Color Computer
$36	PD.D2P	Offset of device name
$38	PD.XON	ACIA x-on character
$39	PD.XOFF	ACIA x-off character
$3A	PD.ERR	Most recent I/O error status
$3B	PD.TBL	Device table address (copy)

These, and many other OS/9 symbols, are defined in several standard library files in the "defs" directory. Some of these definition files are as follows:

```
defs/os9defs.2
defs/os9sysdefs.11
defs/os9iodefs.1
defs/os9rbfdefs.2
defs/os9scfdefs.1
defs/ll.equates
defs/systype
defs/sysdefs.sys
```

Not only do these definition files describe the request codes and error messages; they describe the entire environment in which the OS/9 operating systems and all programs running under it operate, including machine parameters, and descriptor offsets. All S/9 modules and almost all other programs running under OS/9 use the standard OS/9 symbols. The only major variation from the standard naming conventions was caused by Microwave, when they renamed many symbols from the old names used in OS/9 versions lower than 1.2 to the symbols currently used. However, they provide cross-reference definition files to allow the alternate use of the old symbol names.

FLEX AND SBUG FACILITIES

The FLEX storage locations of interest to application programs are as follows:

Address Range	Name	Description
$0000-$bfff	------	application program area
$c000-$007f	stack	FLEX stack
$c080-$c0ff	inbuff	command line buffer
$c100-$c6ff	cmdadr	utility load area
$cB00-$c93f	sysfcb	system file control block
$ca0D-$cbff	spffcb	spool file control block
$cc00	bspchr	ttyset backspace
$cc01	delchr	ttyset delete
$cc02	eolchr	ttyset end of line
$cc03	depth	ttyset depth count
$cc04	width	ttyset width count
$cc05	nulls	ttyset null count
$cc06	tabchr	ttyset tab
$cc07	bsechr	ttyset backspace echo
$cc08	eject	ttyset eject count
$cc09	pause	ttyset pause control
$cc0a	escchr	ttyset escape
$cc0b	s_drn	system drive number
$cc0c	w_drn	working drive number
$cc0d	sysflg	use system drive flag
$cc0e	sysmon	system month
$cc0f	sysday	system day
$cc10	sysyer	system year
$cc11	lsttrm	last terminator
$cc12	usrcmd	user command table
$cc14	cbufpt	line buffer pointer
$cc16	escret	escape return
$cc18	curchr	current character
$cc19	prevch	previous character
$cc1a	curlct	current line number
$cc1b	loadad	loader address offset
$cc1d	xfrflg	transfer flag
$cc1e	xfradr	transfer address
$cc20	errtyp	error type
$cc21	ioflag	special I/O flag
$cc22	outswt	output switch
$cc23	inswt	input switch
$cc24	foaddr	file output address
$cc26	fiaddr	file input address
$cc28	docmdf	command flag
$cc29	curcol	current output column
$cc2b	memend	memory end
$cc2d	errvec	error name vector
$cc2f	fiecho	file input echo flag
$cc30	flag	fms in use flag
$cc31	curtsk	current task pointer
$cc33	cputyp	cpu type flag
$cc34	mode	mode flag
$cc35	pt rap	reserved printer area pointer
$cc37	pf len	reserved printer area length
$cc39	pf dev	printer device address
$cc43	retadr	docmd return address
$cc49	uicflg	upper/lower case flag
$cc4e	prompt	pointer to prompt string
$ccc0	ptnit	printer initialization
$ccd0	ptrm	printer close routine
ccd8	pchk	printer ready check routine
$cce4	pout	printer output routine
$ccfc	prcflg	active spooling flag

$d3a0		dummy	rts for reserve memory function
$d409		fcbase	FMS FCB base pointer
$d40b		fcbcur	FMS FCB current address
$d435		verify	FMS verify flag
$d436		surtab	FMS surnams table

The FLEX service routines maintain the DP, Y, and U registers, but generally modify some or all of the other registers. The FLEX entry vectors of interest to application programs are as follows:

Address		Name	Description
$c700		sched	spool swi handler
$c703		loop	spool nothing-to-do loop
$c706		stersp	spool entry
$c709		tstset	spool test and set flag
$c70c		clrflg	spool clear flag
$c70f		ientry	spool irq handler
$cd00		coldx	cold start
$cd03		warmx	warm start
$cd06		rentar	re-entry
$cd09		inch	basic input character
$cd0c		inch2	basic input character from console
$cd0f		outch	basic output character
$cd12		outch2	basic output character to console
$cd15		getchr	get character
$cd18		putchr	put character
$cd1b		inbuff	input into line buffer
$cd1e		pstrng	print string
$cd21		class	classify character
$cd24		pcrlf	print crlf
$cd27		nxtch	get next buffer character
$dc2e		rstrio	restore I/O vectors
$cd2d		getfil	get file specs
$cd30		load	load binary file
$cd33		setext	set extension
$cd36		addbx	add b to x
$cd39		outdec	output decimal number
$cd3c		outhex	output hexadecimal number
cd3f		rptorr	report error
$cd42		gethex	get hexadecimal number
$ d45		outadr	output hexadecimal address
$cd48		indec	input decimal number
$cd4b		docmnd	call FLEX as a subroutine
$cd4e		stat	check console status
$d3de	(1)	intap	input tape vector
$d3e1	(1)	setirq	set irq vector
$d3e3	(1)	clrirq	clear irq vector
$d3e5	(1)	tinch	console input without echo
$d3e7	(1)	ihandl	irq handler
$d3e9	(1)	swivec	swi vector
$d3eb	(1)	irqvec	irq vector
$d3ed	(1)	t off	timer off
$d3ef	(1)	t on	timer on
$d3f1	(1)	t init	timer init
$d3f3	(1)	xmntor	monitor warm start
$d3f5	(1)	tinit	console init
$d3f7	(1)	tcheck	console check
$d3f9	(1)	toutch	console output
$d3fb	(1)	tinchx	console input with echo
$d3fd		jmpinf	FLEX initialization
$d400		fmsini	FMS initialization
$d403		fmscls	FMS close files
$d406		fms	FMS call
$de00		dread	basic read disk
$de03		dwrite	basic write disk
$de06		dverfy	basic verify disk
$de09		drest	basic restore disk
$de0c		drive	basic select drive
$de0e		dchack	basic check drive ready
$de12		dquick	basic quick drive check
$de15		dcolds	basic driver cold start
$de18		dwarms	basic driver warm start
$de1b		dseek	basic drive seek-to-sector

The SBUG locations of interest to application programs are as follows:

Addresses	Name	Description
$d8c0	user-v	user interrupt vector
$d8c2	swi3-v	swi3 interrupt vector
$d8c4	swi2-v	swi2 interrupt vector
$d8c6	firq-v	firq interrupt vector
$d8c8	irq-v	irq interrupt vector
$d8ca	swi-v	swi interrupt vector
$d8cc	svc-vp	swi2 vector origin address
$d8ce	svc-vl	swi2 vector limit address
$dfd0-$dfdf	datmap	dat map copy

The SBUG entry vectors of interest to application programs are as follows:

Address		Name	Description
$f800	(1)	monitor	monitor cold start
$f802	(1)	nextcmd	monitor warm start
$f804	(1)	inch	get character from console
$f806	(1)	inche	get character from console and echo
$f808	(1)	inchek	check for input from console
$f80a	(1)	outch	display character on console
$f80c	(1)	pdata	display character string to $04
$f80e	(1)	pcrlf	display carriage return/line feed
$f810	(1)	pstrng	display cr/lf, then display string to $04
$f812	(1)	lra	load real 20-bit address of memory location

Note that most of the vector entry points start with a byte containing a 6809 "jmp" instruction ($7e), so that they may be invoked with a "jmp" or "jsr" instruction in the application program. The exceptions are marked with "(1)" in the table above. These entry points are usually invoked with indirect addressing (i.e. jsr [$d3e5]). Occasionally the other entry points are invoked indirectly, by using the address in the entry point without the preceding "jmp" (at the stated address plus one).

The SBUG entry point vectors and storage locations are also presented above, since many application programs invoke the SBUG facilities directly, rather than using them thru FLEX, for various reasons, such as to avoid the input and output redirection caused by the "<", ">", and "*" pre-commands.

As described earlier, FLEX performs all disk I/O thru the File Management System (FMS). The requestor indicates the action to be performed by placing a code into the FMS function code of the corresponding FCB. The File Management System function codes are as follows:

Code	Description
$00	get/put next byte
$01	open-input
$02	open-output
$03	open-update
$04	close
$05	rewind
$06	open directory
$07	get information record
$08	put information record
$09	read single sector
$0a	write single sector
$0b	extend directory
$0c	delete
$0d	rename
$0f	get next sequential sector
$10	open system information record
$11	get random byte from sector
$12	put random byte into sector
$13	open-extend
$14	find next drive
$15	position to record n
$16	back up one record

The requestor places one of these codes into the FCB function code before invoking FMS. The FMS file control block (FCB) has the following format:

Offset	Description
$00	function code
$01	error status
$02	activity status
$03	drive number
$04-$0b	name
$0c-$0e	extension
$0f	file attributes
$11-$12	starting disk address
$13-$14	ending disk address
$15-$16	file size
$17	file sector map indicator
$18	assigned drive number
$19	creation month
$1a	creation day
$1b	creation year
$1c-$1d	list pointer
$1e-$1f	current position
$20-$21	current record number
$22	data index
$23	random index
$24-$2e	name work buffer
$2f-$31	current directory address
$32-$35	first deleted directory pointer
$35-$3a	rename work area
$3b	space compression flag
$40-$13f	sector buffer

When a program invokes the FMS and passes parameters to it thru an FCB, FMS returns an error indicator (the carry flag) and an error code in the same FCB. The FMS error codes are as follows:

Number	Description
00	no error
01	illegal FMS function code
02	the requested file is in use
03	the specified file already exists
04	the specified file count not be found
05	system directory error-reboot system
06	the system directory space is full
07	all available disk space has been used
08	read past end of file
09	disk file read error
10	disk file write error
11	the file or disk is write protected
12	the file is protected-file not deleted
13	illegal file control block specified
14	illegal disk address encountered
15	an illegal drive number was specified
16	drives not ready
17	the file is protected-access denied
18	system file status error
19	FMS date index range error
20	FMS inactive-reboot system

```
21      illegal file specification
22      system file close error
23      sector map overflow-disk too segmented
24      nonexistent record number specified
25      record number mismatch error-file damaged
26      command syntax error-retype command
27      command not allowed while printing
28      wrong hardware configuration
```

Most of the FLEX symbols are defined in a standard SWTPC library file named FLEXLIB. Unfortunately, the symbols are not used in a standard manner by TSC or by any of the FLEX licensees. Many programs ignore any naming conventions and create their own names, or simply refer to the absolute addresses of the FLEX vectors and storage locations directly. The names used above will be used for this discussion, however.

OS/9 PROGRAM REQUIREMENTS

OS/9 requires that all application modules have a module header and a module trailer, and that the program code and data possess the attribute of position-independence. The OS/9 assemblers generate the proper formats and contents for the module header and trailer, and warn the programmer in the case of non-position-independent construct usage, but it is the programmer's responsibility to ensure the correctness of the position-independence aspects of the program.

The same format is required for memory and disk representations of executable OS/9 modules. OS/9 modules are required to be contiguous on disk and in memory, although an OS/9 program may be composed of more than one OS/9 executable module. Each module is assembled relative to a base address of zero, but is loaded at whatever addresses that OS/9 determines will contain the module.

The OS/9 module header for executable modules has the following format:

Offset	Name	Description
$00-$01	M$ID	ID code of $87cd
$02-$03	M$Size	Module size
$04-$05	M$Name	Module name offset
$06	M$Type	Type and language
$07	M$Revs	Attribut s and revision level
$08	M$Parity	Header parity
$09	M$IDSize	Module ID size
$0a-$0b	M$Exec	Execution offset
$0c-$0d	M$Store	Data storage size

The module trailer is three bytes in length and its contents is based on a check-sum computation of the entire module, starting with the "$87cd" in the module header.

Conversion of existing programs to possess position-independent code and data structures may be quite straightforward, primarily involving the changes described below, or it may be exceedingly complex. The complexities usually arise in situations involving heavy use of indexed addressing with sixteen-bit offsets, because of the ambiguities between addresses, offsets, and sixteen-bit data fields.

All OS/9 application program code is required to be written using pure position-independent code and data techniques, as noted earlier. When a data space is allocated to an application program to be executed, OS/9 points the U and DP registers to the beginning of the data space, the S and X registers to the end, the Y register to the end of the end of the parameter area (of which X points to the beginning), and the PC register to the beginning of the module plus the execution offset, as specified in the module header.

Because of the multi-user capability of OS/9 modules, the program code area is almost always shared among all the users of a given module, and thus locations within the program must not be altered once a module is brought into memory. Thus, PC-relative store operations are normally forbidden under OS/9, although the hardware will not usually detect such violations, providing the user the task of writing or modifying programs to obey such restrictions, and of converting many PC-relative storage locations to be logically S-relative, U-relative, X-relative, or Y-relative.

Since the offset between the program load point and the data load point is unknown before a program is executed by a particular user, position-independent references (",S", ",U", ",X", ",Y") must be used. In addition, the application program, not OS/9, is responsible for all initialization in the data space; thus constant information (such as tables) should be placed in the program space and referenced in a position-independent-code (",PCR") manner, or copied to the data space. Program packages such as the Microware "C" compiler perform this task as a part of initialization.

The simplest manner in which to convert or write position-independent code references is to suffix all direct and extended addresses used in instructions with ",PCR" or ",U" for all extended address references that are within the program area or data area, respectively. This process is not always performed without problems. Specific problems with the conversion of immediate addresses and table references are discussed below.

Because the OS/9 assemblers attempt to optimize the use of the U-register, and the U-register points to the base of the allocated data area, the data area must be specified before any references to it are made, or the assembler may generate "Phase Error" messages, since it assumes 16-bit offset addressing on the first pass and may discover 0-bit, 5-bit, or 8-bit offset addressing on the second pass. Similarly, symbols should be defined before use, whenever possible, to prevent similar problems with other registers.

Fixed references external to the program must be absolute addresses under OS/9 Level 1, since the effective addresses computed using the program counter would very if the application program were moved to a different location than the assumed zero load point. Fixed external references are generally invalid under OS/9 Level 2, since the I/O, OS/9, and other application program areas are mapped out of the application program's address space.

Rather than "jmp" or "jsr" for PC-relative references, the instructions "bra/lbra" or "bsr/lbsr" must be used. The latter instructions accomplish exactly the same purpose, but are slower and longer than the former. They are used when longer branches are required.

Because OS/9 modules must be contiguous and assembled relative to address zero, the assembler "org" statement may not normally be used. FLEX programs containing "org" statements must be reviewed to determine the effect of removing them; often, the effects are very minor.

For 6800 compatibility, FLEX programs have often been coded using the 6800 mnemonics, such as "tba" and "tde a". The OS/9 assemblers will not accept the 6800 mnemonics. Thus FLEX programs being converted to OS/9 must be purged of 6800 mnemonics. This task is easily accomplished with a text editor or a commercial translator.

Addresses used in an immediate context may require much attention to achieve position independance. A load instruction of the following format:

```
ldr  #addr
```

where r = s, u, x, or y, and "addr" is not external to the program code nor a non-address constant, should be coded in one of the following formats:

```
lear addr,pcr    or    lear addr,u
```

for position independence.

In the case of statements of the following format involving the "D" register:

```
ldd  #addr
```

the 6809 has no "lead" instruction, and it must be rewritten using one of the other sixteen-bit registers, without causing side-effects. The following code, which provides equivalent results in the "d" and "cc" registers (but changes no other registers), could be used:

```
pshs x
lear addr,pcr    or    lear addr,u
pshs x
ldd  ,s++
puls x
```

Sixteen-bit compare instructions of the following format:

```
cmpr  #addr
```

(where "r" and "addr" are as defined above) must be rewritten, since there is no compare effective address instruction. For r = u, x, or y, code of the following format could be used:

```
pshs r,d
lear (-($ffff-addr)+1),pcr    or    lear (($ffff-addr)+1),u
tfr  r,d
addd $02,s
puls r,d
```

For r = s, code of the following format could be used:

```
pshs u,d
leau ($fffe-addr),pcr    or    leau ($fffe-addr),u
pshs u
tfr  s,d
addd ,s++
puls u,d
```

For r = d, code of the following format could be used:

```
pshs x
leax addr,pcr    or    leax addr,u
pshs x
cmpd ,s++
puls x
```

The general solution to the problem of conversion of address tables to position-independance is to code the addresses in the table as offsets from some base point, where the base point is chosen in some manner convenient to the situation. Two typical base points are the beginning of the table itself and the beginning of the module, for single-module programs. The primary advantage of using the beginning of the module is that the relative offsets and extended addresses are identical, assuming that the module starts at address zero. The primary advantage of using the beginning of the table is that the beginning address is already loaded in a register when the effective address is being calculated, saving one instruction.

For example, consider the following program fragments:

```
        :
        :
        lda   index,u       get table index
        lenx  table,pcr     get table base address
        aslb                multiply index by two
        ldd   a,x           get table entry
        ldd   d,x           get value at address
        :
        :
table   fdb   addr1-table   table entries
        fdb   addr2-table
        fdb   addr3-table
        fdb   addr4-table
        :
        :
```

If the address of the beginning of the module is used as a base point, an instruction such as the following:

```
        leax  start,pcr     get beginning address
```

would be inserted between the two "ldd" instructions and the "-table" terms would be dropped from the table entries, or changed to "-start".

In the case of complex symbolic expressions involving several labels, the assumed bases of each of the labels in the expression must be checked to assure that the expression is meaningful when the program is position-independent in code and data.

For example, in the following program fragment:

```
        :
        :
ulabel  rmb 1                   u-relative label
ulabel1 rmb 1                   :
ulabel2 rmb 1                   :
        :
        :
pcrel   leax (pcrel-ulabel),pcr     pc-relative label
urel    leax (urel-ulabel),u        u-relative label
        :
        :
```

the values of symbolic expressions of the form "(pcrel-ulabel)" and "(urel-ulabel)" are meaningless with either ",PCR" or ",U" suffix, since the offset between the program module load point and the start of the data space (represented by the U register) is not constant.

Expressions must normally be built using symbols based upon the same register. However, expressions or sub-expressions of the following formats:

```
(ulabel1-ulabel2)
(urel-pcrel)
```

are meaningful since they specify constant values, assuming both symbols are based upon the same register, as in the example above.

There are several differences between the FLEX assemblers and OS/9 assemblers which must be understood to read the example OS/9 programs provided later in this article. The first difference is found in the library call pseudo-opcode. FLEX assemblers require "lib", whereas OS/9 assemblers require "use". The "opt" pseudo-opcode operands are also different among the assemblers. OS/9 assemblers use "." rather than "*" to designate the data counter, which is analogous to the program counters used by FLEX and OS/9 assemblers.

FLEX PROGRAM REQUIREMENTS

FLEX places very few requirements on application programs written to execute under its control. There are two areas into which FLEX programs are normally loaded, as follows:

```
$0000-memend    application program area
$c100-$c6ff     utility program area
```

where "memend" represents a value maintained by FLEX which specifies the end of the user address space. The value of "memend" may be changed by FLEX system programs and by device drivers stealing space from the user area in order to become memory-resident.

The FLEX representation of an object program code extent on disk is as follows:

```
$02             indicator of code extent
high address    high byte of extent address
low address     low byte of extent address
count           number of bytes in extent
data            contents of extent;
```

and the FLEX representation of the transfer address of an object program is as follows:

```
$16             indicator of transfer address
high address    high byte of transfer address
low address     low byte of transfer address;
```

where a given object file may be composed of any number of extents and transfer addresses. Each extent is loaded independently of all others, providing the facility of discontiguous program code loading. The last-found transfer address is used as the initial program execution address. A transfer address is normally required in order to execute a program.

FLEX has no protection against an application or system program being loaded over itself or over other memory-resident programs or device drivers. It is the user's responsibility to ensure that the program address spaces do not conflict. Since FLEX is inherently single-user, this does not usually cause problems. Programs such as BASIC and assemblers use "memend" to determine the end of the application program area in order to utilize the maximum amount of memory available.

FLEX device drivers (and certain other system programs) must possess position-independency, but FLEX does not take any special actions for position-independent application programs. In fact, since position-independent 6809 programs are generally longer, slower, and harder to write then those that are not, most FLEX application programs are not position-independent.

Although FLEX supports only a limited number of devices, system and application programs have access to all of the 64K bytes of the address space, and are free to implement any internal devices, as required. FLEX will not recognize these devices unless the programs are written as device drivers. In this case, the drivers are recognized as either a output or input device or disk device; however, disk devices are designated as drives numbered zero thru three, restricting the number of disk drives to four.

OS/9 IMPLEMENTATION OF FLEX AND SBUG ENTRY POINTS

This section discusses the implementation of FLEX assembly language programs in OS/9 assembler language, primarily in terms of the conversion of the FLEX and SBUG entry points. In many cases, the suggested conversions are approximate, and problems are usually noted as such.

All the conversions are symbolic and indicative of the logic conversions required, not necessarily indicative of the specific conversions necessitated by a given situation in a specific program. Undocumented side-effects of FLEX entry points are not implemented in the suggested conversions. Unused registers are maintained.

The use of FLEX and SBUG entry points not included in the list below must be carefully investigated; most are not convertible to OS/9 and logic using them must be deleted or rewritten.

Note that all OS/9 console I/O may be redirected from the command line, whereas FLEX has entry points and switches which can override console I/O redirection. This may effect logic in many programs being converted which use FLEX and SBUG entry points such as the following:

```
inch/inch2
outch/outch2
getchr
putchr
tinch
toutch
inche/tinche
```

those programs using other FLEX entry points with I/O to the console, and those programs which use the FLEX switches "inswt" and "outswt" to control redirection of console I/O.

The problems involved in console I/O redirection under OS/9 and the differences between the handling of the command lines and file names of FLEX and OS/9 may also cause logic changes in programs using the following FLEX entry points to scan the command line:

```
inbuff
nxtch
getfil
setext
```

The conversions described below may be used in several different manners.

In short programs, the simplest technique may, in many cases, be to substitute the equivalent code directly on each occurrence of the calls. This has the advantage that it may be easier to understand and to accomplish. Complicating factors in this method may be secondary entry points (in which one conversion routine calls another), changed code sequence length (requiring the substitution of long branches for short branches), and loss of structure and modularity of the program code.

In longer programs, one copy of each of the OS/9 equivalent code groups used in each program could be included and invoked with "lbra" or "lbsr", replacing the "jmp" or "jsr" in the original FLEX program code. Indirect jumps and subroutine calls to the FLEX and SBUG entry points must be changed to the corresponding relative branches.

Still another technique would be to use a complete emulator to run FLEX programs effectively as-is under OS/9. This would not accomplish the conversion of FLEX programs to OS/9 programs, but would allow the use of FLEX programs under OS/9, with limitations.

The technique suggested in the descriptions below involves the use of a conversion subroutine library to provide facilities similar to those provided by the original FLEX program code.

SUGGESTED CONVERSIONS

The following entry points return to FLEX or SBUG. The OS/9 equivalent returns to OS/9 with a zero return code, which may be modified to indicate various error or logical conditions.

```
Entry Point    Parameters        Conversion                 Comments

colds                            warms clrb
warms                                  os9   F$Exit
renter
montor
monitor
nextcmd
```

The following entry points wait for, input, and echo a character from the FLEX or SBUG console input device. The OS/9 equivalent performs the same action; however, standard input redirection may cause problems in reading from the desired OS/9 console input device. Also, the OS/9 console drivers may mask character parity, ignore certain character codes, and otherwise perform differently than the FLEX console drivers; many of these actions may be changed by modifying the OS/9 device descriptor for the console.

```
Entry Point    Parameters     Conversion            Comments

inch (FLEX) returns     getchr pshs   b,x,y,u
inch2          a=char          leas   -$01,s
inche                          tfr    s,x
tinche                         ldy    #$0001
                               clra
                               os9    I$Read
                               lda    ,s+
                               puls   b,x,y,u,pc

getchr       returns    getchr pshs   b,x,y,u
               a=char          leas   -$01,s
                               tfr    s,x
                               ldy    #$0001
                               clra
                               os9    I$ReadLn
                               lda    ,s+
                               puls   b,x,y,u,pc
```

The following entry points wait for and input a character from the FLEX or SBUG console input device. The OS/9 equivalent performs the same action; however, standard input redirection may cause problems in reading from the desired OS/9 console input device. Also, the OS/9 console drivers may mask character parity, ignore certain character codes, and otherwise perform differently than the FLEX console drivers; many of these actions may be changed by modifying the OS/9 device descriptor for the console.

```
Entry Point    Parameters     Conversion            Comments

inch (SBUG) returns     tinch  pshs   d,x,y,u
tinch          a=char          leas   -$20,s
                               tfr    s,x
                               clra
                               clrb
                               os9    I$GetStt
                               clr    pd.eko-$20,x
                               os9    I$SetStt
                               leax   $20,s
                               ldy    #$0001
                               clra
                               os9    I$Read
                               tfr    s,x
                               clra
                               clrb
                               inc    pd.eko-$20,x
                               os9    I$SetStt
                               leas   $20,s
                               puls   d,x,y,u,pc
```

The following entry points check for input ready on the FLEX or SBUG console input device. The OS/9 equivalent performs the same action; however, standard input redirection may cause problems in reading from the desired OS/9 console input device.

```
Entry Point    Parameters     Conversion            Comments

stat         returns    stat   pshs   d,x,y,u
```

```
tcheck      z=nready        ldd     #$0001
inchek                      os9     I$GetStt
                            andb    #$02
                            comb
                            puls    d,x,y,u,pc
```

The following entry points output a character to the FLEX or SBUG console output device. The OS/9 equivalent performs the same action; however, standard output redirection may cause problems in reading from the desired OS/9 console output device. Also, the OS/9 console drivers may mask character parity, add line feeds after carriage returns, and otherwise perform differently than the FLEX console drivers; many of these actions may be changed by modifying the OS/9 device descriptor for the console.

Entry Point	Parameters		Conversion		Comments
outch	a=char	outch	pshs	d,x,y,u	
outch2			tfr	s,x	
toutch			ldy	#$0001	
			lda	#$01	
			os9	I$Write	
			puls	d,x,y,u,pc	
putchr	a=char	putchr	pshs	d,x,y,u	
			tfr	s,x	
			ldy	#$0001	
			lda	#$01	
			os9	I$WritLn	
			puls	d,x,y,u,pc	

The following entry points output a string of characters to the FLEX or SBUG console output device. The OS/9 equivalent performs the same action; however, standard output redirection may cause problems in reading from the desired OS/9 console output device. Also, the OS/9 console drivers may mask character parity, add line feeds after carriage returns, and otherwise perform differently than the FLEX console drivers; many of these actions may be changed by modifying the OS/9 device descriptor for the console.

Entry Point	Parameters		Conversion		Comments
pstrng	x=>string	pstrng	bsr	pcrlf	
			bsr	pdata	
			rts		
pdata	x=>string	pdata	lda	,x+	
			cmpa	#$04	
			beq	pdatex	
			lbsr	outch	
			bra	pdata	
		pdatex	rts		
pcrlf		pcrlf	pshs	a	
			lda	#$0d	
			lbsr	putchr	
			puls	a,pc	

The following entry point waits for, inputs, and echoes a line from the FLEX console input device. The OS/9 equivalent performs the same action; however, standard input redirection may cause problems in reading from the desired OS/9 console input device. Also, the OS/9 console drivers may mask character parity, ignore certain character codes, and otherwise perform differently than the FLEX console drivers; many of these actions may be changed by modifying the OS/9 device descriptor for the console.

The buffer used by the routine must be defined as at least 128 bytes in length and should be initialized to the contents of the command line, as shown below, before any of the registers passed to the module have been modified.

Entry Point	Parameters		Conversion		Comments
inbuff	returns	inbuff	pshs	d,x,y,u	
	inbuff		leax	inbuff,u	
			stx	cbufpt,u	
			ldy	#$7f	
			clrb		
			os9	I$Readln	
			puls	d,x,y,u,pc	
initial		initial	pshs	d,x,y	
			leay	inbuff,u	
		initl1	lda	,x+	
			sta	,y+	
			cmpa	#$0d	
			bne	initl1	
			puls	d,x,y,pc	

The following entry point classifies the character represented by the A register. If the character is alphabetic or numeric, the routine returns with the carry flag cleared. Otherwise, it returns with the carry flag set and the character in the last terminator location.

Entry Point	Parameters		Conversion		Comments
class	a=char	class	cmpa	#$30	
	returns		bcs	classn	
	cc=class		cmpa	#$39	
			bls	classa	
			cmpa	#$41	
			bcs	classn	
			cmpa	#$5a	
			bls	classa	
			cmpa	#$61	
			bcs	classn	
			cmpa	#$7a	
			bhi	classn	
		classa	andcc	#$fe	
			rts		
		classn	orcc	#$01	
			sta	tsttrm,u	
			rts		

The following entry point returns the next character from the input buffer (constructed by the "inbuff" entry point) in the A register. It skips multiple spaces and also classifies the character, but will not scan beyond the end of the logical or physical line.

Entry Point	Parameters		Conversion		Comments
nxtch	returns	nxtch	pshs	b,x,y,u	
	a=char		lda	curchr,u	
	cc=class		sta	prvchr,u	
			ldx	inbuff,u	
		nxtch1	lda	,x+	
			sta	curchr,u	
			cmpa	ttyeol,u	
			beq	nxtch2	
			cmpa	#$0d	
			beq	nxtch2	
			stx	inbuff,u	
			cmpa	#$20	
			bne	nxtch2	
			cmpa	,x	
			beq	nxtch1	
		nxtch2	lbsr	class	
			puls	b,x,y,u,pc	

The following entry point converts the 16-bit unsigned integer pointed to by the X register to decimal and outputs it to the FLEX console output device. If the B register is non-zero on entry, the routine will output leading spaces; otherwise, it will suppress leading spaces and zeroes.

Entry Point	Parameters		Conversion		Comments
outdec	x=>number	outdec	pshs	d,x,y,u	
			ldd	#$3004	
			pshs	d	
			ldd	,x	
			leax	outdes,pcr	
			ldy	#$0000	
		outdem	cmpd	,x	
			bhs	outdeg	
		outded	pshs	d	
			ldd	$02,s	
			cmpy	#$0000	
			bne	outdep	
			tsta		
			bne	outdel	
			tstb		
			beq	outden	
			lda	#$20	
			bra	outdep	
		outdel	leay	$01,y	
		outdep	lbsr	putchr	
		outden	lda	#$30	
			sta	,s	
			puls	d	
			dec	$01,s	
			beq	outdex	
			leax	$02,x	
			bra	outdem	
		outdeg	inc	,s	
			subd	,x	
			bra	outdem	
		outdex	puls	d	
			ttr	b,a	
			ora	#$30	
			lbsr	putchr	
			puls	d,x,y,u,pc	
		outdes	fdb	10000	
			fdb	1000	
			fdb	100	
			fdb	10	

The following entry points convert the 16 bit or 8 bit number pointed to by the X register to hexadecimal and outputs it to the FLEX console output device.

Entry Point	Parameters		Conversion		Comments
outadr	x=>number	outadr	bsr	outhex	
			leax	$01,x	
			bsr	outhex	
			rts		
outhex	x=>number	outhex	lda	,x	
			bsr	outhx1	
			lda	,x	
			bra	outhx2	
		outhx1	lsra		
			lsra		
			lsra		
			lsra		
		outhx2	anda	#$0f	
			adda	#$30	
			cmpa	#$39	
			bls	outhx3	

```
                        adda    #$07
                outhx3  lbra    putchr
```

The following entry points convert a hexadecimal or decimal number in the input line buffer and return the result in the X register. The carry bit is cleared on exit if a valid number was found.

Entry Point	Parameters	Conversion		Comments
gethex	returns	gethex	pshs	d,y,u
	x=number		ldx	#$0000
	cc=valid	gethx1	lbsr	nxtch
			bcs	gethx6
			cmpa	#$5f
			bls	gethx2
			suba	#$20
		gethx2	suba	#$47
			bpl	gethx5
			adda	#$06
			bpl	gethx3
			adda	#$07
			bpl	gethx5
		gethx3	adda	#$0a
			bmi	gethx5
			exg	d,x
			aslb	
			rola	
			aslb	
			rola	
			aslb	
			rola	
			aslb	
			rola	
			exg	d,x
			leax	a,x
			bra	gethx1
		gethx5	lbsr	nxtch
			bcc	gethx5
			puls	d,y,u,pc
		gethx6	andcc	#$fe
			puls	d,y,u,pc
Indec	returns	Indec	pshs	d,y,u
	x=number		ldx	#$0000
	cc=valid	Indec1	lbsr	nxtch
			bcs	Indec3
			cmpa	#$39
			bhi	Indec2
			pshs	x
			exg	d,x
			aslb	
			rola	
			aslb	
			rola	
			aslb	
			rola	
			addd	,s
			addd	,s++
			exg	d,x
			anda	#$0f
			leax	a,x
			bra	Indec1
		Indec2	lbsr	nxtch
			bcc	Indec2
			puls	d,y,u,pc
		Indec3	andcc	#$fe
			puls	d,y,u,pc

The following entry point adds the contents of the B register to the contents of the X register and returns the result in the X register. It was included in FLEX 9 for compatibility with FLEX 2 on the 6800.

Entry Point	Parameters	Conversion		Comments
addbx	x+b=x	addbx	abx	
			rts	

The following entry point formats an error message and outputs it to the FLEX console output device. The error number is found in the FCB pointed to by the X register.

Entry Point	Parameters	Conversion		Comments
rpterr	x=>FCB	rpterr	pshs	d,x,y,u
			lda	#$02
			ldb	$01,x
			os9	F$PErr
			puls	d,x,y,u,pc

The following entry points transfer a FLEX file name from the line buffer to an FCB to which the X register points and provide a default file name suffix. If the format of the file name is not valid, the carry flag will be set on exit from the routine and the error field in the FCB will be set to 21 (Illegal File Specification). However, since the formats and lengths of the file names are quite different between the two systems, there can be no direct equivalent under OS/9.

The conversion suggested below combines the external functions of the two FLEX entry points into one routine which locates an OS/9 path and file name in the line buffer, points the Y register to the beginning of the file name, and sets the A register to the length of the file name. If the format of the file name is not valid, the carry flag will be set, the FCB error field will be set to 21, and the A register will be set to zero. The other changes caused by these differences must be handled separately.

Entry Point	Parameters	Conversion		Comments
getfil	x=>FCB	getfil	pshs	b,x,u
setext			ldx	cbufpt,u
			clra	
		getfl1	tfr	x,y
			ldb	,x+
			cmpb	#$20
			beq	getfl1
			cmpb	#$2e
			beq	getfl2
			cmpb	#$2f
			beq	getfl2
			cmpb	#$41
			blo	getfl3
			cmpb	#$5a
			bls	getfl2
			cmpb	#$5f
			beq	getfl2
			cmpb	#$61
			blo	getfl3
			cmpb	#$7a
			bhi	getfl3
		getfl2	inca	
			ldb	,x+
			cmpb	#$2e
			beq	getfl2
			cmpb	#$2f
			beq	getfl2
			cmpb	#$41
			blo	getfl3
			cmpb	#$5a
			bls	getfl2
			cmpb	#$5f
			beq	getfl2
			cmpb	#$61
			blo	getfl3
			cmpb	#$7a
			bls	getfl2
		getfl3	cmpb	#$0d
			beq	getfl4
			cmpb	#$21
			beq	getfl4
			cmpb	#$2f
			beq	getfl4
			cmpb	#$3b
			bne	getfl5
		getfl4	leax	-$01,x
		getfl5	stx	chutpt,u
			tsta	
			beq	getfl7
		getfl6	andcc	#$fe
			puls	b,x,u,pc
		getfl7	ldb	#$15
			ldx	$01,s
			stb	$01,x
			orcc	#$01
			puls	b,x,u,pc

The following entry point loads a binary file the name of which is contained in the system FCB (sysfcb). The nearest OS/9 equivalent of the FLEX entry point requires that the X register point to the name of the file, advances the X register past the name, and sets the carry flag and B register in case of error.

Entry Point	Parameters	Conversion		Comments
load		load	os9	F$Load
			bcc	loadx
			os9	F$PErr
		loadx	rts	

The following entry point passes the line buffer to FLEX as a command line. FLEX processes the contents of the line buffer and returns the last FMS error code in the B register. The primary differences between the FLEX entry point and the nearest OS/9 equivalent lie in the command line formats, the error code interpretations, and the new process id returned in the A register.

Entry Point	Parameters	Conversion		Comments
docmnd	inbuff	docmnd	pshs	x,y,u
			leax	docmns,pcr
			ldy	#$007f
			leau	inbuff,u
			clre	
			clrb	
			os9	F$Fork
			bcs	docmnx
			os9	F$Wait
		docmnx	puls	x,y,u,pc
		docmns	fcs	"Shell"

The following entry points perform all disk-related operations for the remainder of FLEX and for application programs executing under control of FLEX. As noted earlier, all communications to the File Management System (FMS) are thru the File Control Block (FCB) and all communications from the FMS are thru the FCB and the zero flag.

There are very few OS/9 system request equivalents for the FLEX FMS function codes. There is no direct equivalent for the FCB. Since many of the FMS functions use or deposit data from or into the FCB, the FCB is assumed maintained in the suggested conversions listed below. However, the OS/9 path name is potentially much longer than the FLEX file name, must be maintained separately from the FCB, and its address must be passed in the Y register.

Any FMS functions dealing with the FLEX SIR, random files and records, the directory, or full sectors cannot be directly translated to

OS/9. Any references to these functions are highly system-dependent and must be carefully investigated and modified or eliminated. Often, OS/9 provides a direct means to accomplish what in FLEX is fairly difficult or obscure. An example of this is that OS/9 allows the direct reading of a directory as if it were a file, whereas FLEX has separate FMS entry points for reading the directory.

The conversions below assume that the FMS functions will be separate. An alternative organization would be to provide one entry point and have logic there to separate the functions by the FCB function code; however, in the majority of cases, definite FMS functions are called, making a single entry point superfluous.

Thus, this area of conversion from FLEX to OS/9 will probably require more effort in a given program than will the remainder of the areas of conversion.

```
Entry Point     Parameters      Conversion          Comments

fmsini                          fmsini rts          initialize FMS

fmscls                          fmscls rts          close all files

fms             fcn=00          fms00  pshs  d,x,y,u  get/put byte
                get/put           clr   $01,x
                  anchar          ldd   $02,x       status and path
                x=>FCB            tfr   x,x
                                  ldy   #$0001
                                  cmpe  #$02
                                  tfr   b,e
                                  bne   fms00r
                                  os9   I$Write
                                  bra   fms00f
                                fms00r os9  I$Read
                                fms00f orcc #$04
                                       bcc  fms00x
                                       ldx  $02,s
                                       stb  $01,x
                                fms00x puls d,x,y,u

fms             fcn=01          fms01  pshs  d,x,y,u  open input
                y=>name           clr   $01,x
                x=>FCB            lda   ,x
                                  sta   $02,x
                                  lda   #$01        #$05 for binary
                                  exg   x,y
                                  os9   I$Open
                                  sta   $03,y
                                  orcc  #$04
                                  bcc   fms01x
                                  clr   $03,y
                                  stb   $01,y
                                fms01x puls d,x,y,u

fms             fcn=02          fms02  pshs  d,x,y,u  open output
                y=>name           clr   $01,x
                x=>FCB            lda   ,x
                                  sta   $02,x
                                  ldd   #$021b      #$063f for binary
                                  exg   x,y
                                  os9   I$Create
                                  sta   $03,y
                                  orcc  #$04
                                  bcc   fms02x
                                  clr   $03,y
                                  stb   $01,y
                                fms02x puls d,x,y,u

fms             fcn=03          fms03  pshs  d,x,y,u  open update
                y=>name           clr   $01,x
                x=>FCB            lda   ,x
                                  sta   $02,x
                                  lda   #$03        #$07 for binary
                                  exg   x,y
                                  os9   I$Open
                                  sta   $03,y
                                  orcc  #$04
                                  bcc   fms03x
                                  clr   $03,y
                                  stb   $01,y
                                fms03x puls d,x,y,u

fms             fcn=04          fms04  pshs  d,x,y,u  close
                x=>FCB            clr   $01,x
                                  clr   $02,x
                                  lda   $03,x       path
                                  clr   $03,x
                                  os9   I$Close
                                  orcc  #$04
                                  bcc   fms04a
                                  stb   $01,x
                                fms04x puls d,x,y,u

fms             fcn=05          fms05  pshs  d,x,y,u  rewind
                x=>FCB            clr   $01,x
                                  lda   $01,x       path
                                  tfr   x,y
                                  ldx   #$0000
                                  tfr   x,u
                                  os9   I$Seek
                                  orcc  #$04
                                  bcc   fms05x
                                  stb   $01,y
                                fms05x puls d,x,y,u

fms             fcn=06          fms06  rts          open directory
                x=>FCB          *      no OS/9 equivalent

fms             fcn=07          fms07  rts          get info record
                x=>FCB          *      no OS/9 equivalent

fms             fcn=08          fms08  rts          put info record
                x=>FCB          *      no OS/9 equivalent

fms             fcn=09          fms09  rts          read single sector
                x=>FCB          *      no OS/9 equivalent
                                *      (could open device for physical
                                *      sector I/O and use I$Seek)

fms             fcn=0a          fms0a  rts          write single sector
                x=>FCB          *      no OS/9 equivalent
                                *      (could open device for physical
                                *      sector I/O and use I$Seek)

fms             fcn=0b          fms0b  rts          extend directory
                x=>FCB          *      no OS/9 equivalent

fms             fcn=0c          fms0c  pshs  d,x,y,u  delete file
                y=>name           clr   $01,x
                x=>FCB            exg   x,y
                                  os9   I$Delete I$DeletX for binary
                                  orcc  #$04
                                  bcc   fms0cx
                                  stb   $01,y
                                fms0cx puls d,x,y,u

fms             fcn=0d          fms0d  rts          rename file
                x=>FCB          *      no OS/9 equivalent

fms             fcn=0f          fms0f  rts          next next sector
                x=>FCB          *      no OS/9 equivalent

fms             fcn=10          fms10  rts          open sys info rec
                x=>FCB          *      no OS/9 equivalent

fms             fcn=11          fms11  rts          get random byte
                x=>FCB          *      no OS/9 equivalent
                                *      (could use I$GetStt and I$Seek)

fms             fcn=12          fms12  rts          put random byte
                x=>FCB          *      no OS/9 equivalent
                                *      (could use I$GetStt and I$Seek)

fms             fcn=13          fms13  pshs  d,x,y,u  open extend
                y=>name           clr   $01,x
                x=>FCB            lda   #$02
                                  sta   $02,x
                                  lda   #$02        #$06 for binary
                                  exg   x,y
                                  os9   I$Open
                                  sta   $03,y
                                  bcc   fms13a
                                  clr   $03,y
                                  stb   $01,y
                                  puls  d,x,y,u
                                fms13a ldb  #ss.size
                                  os9   I$GetStt
                                  orcc  #$04
                                  bcc   fms13f
                                  stb   $01,y
                                  puls  d,x,y,u
                                fms13f cmpx #$0000
                                  bne   fms13g
                                  cmpu  #$0000
                                  beq   fms13t
                                fms13g leau $01,u
                                  cmpu  #$0000
                                  bne   fms13t
                                  leax  $01,x
                                fms13t os9  I$Seek
                                  orcc  #$04
                                  bcc   fms13x
                                  stb   $01,y
                                fms13x puls d,x,y,u

fms             fcn=14          fms14  rts          find next drive
                x=>FCB          *      no OS/9 equivalent

fms             fcn=15          fms15  rts          position to record n
                x=>FCB          *      no OS/9 equivalent
                                *      (could use I$Seek to byte position)

fms             fcn=16          fms16  rts          back up one record
                x=>FCB          *      no OS/9 equivalent
                                *      (could use I$Seek to byte position)
```

OS/9 IMPLEMENTATION OF FLEX STORAGE LOCATIONS

This section discusses the implementation of the FLEX storage locations under OS/9, assuming the conversions already described are used. As before, some of the suggested storage location conversions are approximate, because of the different orientation OS/9 takes in many areas from FLEX. The use of locations not on this list must be investigated thoroughly and modified or dropped.

name	description	comments
stack	FLEX stack	The FLEX stack area is normally used by programs requiring only a small stack. Explicit reference to the stack may be used to reset it to a known value. If necessary, the initial value of the stack could be saved in order to implement such stack-resetting logic.

inbuff command line buffer
: The command line buffer is used for communication between FLEX and user programs. It must be at least 128 bytes in length and should be initialized to the contents of the parameter area.

sysfcb system file control block
: The system FCB is used by many programs as a temporary additional FCB. A 320 byte area named "sysfcb" may be substituted for the system FCB.

bspchr ttyset backspace
delchr ttyset delete
eolchr ttyset end of line
depth ttyset depth count
width ttyset width count
nulls ttyset null count
tabchr ttyset tab
bsechr ttyset backspace echo
eject ttyset eject count
pause ttyset pause control
escchr ttyset escape
: The FLEX "ttyset" parameters allow the direct determination and specification of certain parameters of the console. Under OS/9, similar parameters are available, but determination of them must be done thru the "os9 I$GetStt" call and specification of them must be done thru the "os9 I$SetStt" call.

s_drn system drive number
: The FLEX system drive number is often used to determine the drive from which to load executable programs. Under OS/9, the system drive number corresponds to the default execution directory.

w_drn working drive number
: The FLEX working drive number is often used to determine the drive from which to load and save data files. Under OS/9, the working drive number corresponds to the default data directory.

sysmon system month
sysday system day
sysyer system year
: The FLEX month, day, and year allow the direct determination and specification of the system date. Under OS/9, similar parameters are available, but determination of them must be done thru the "os9 F$Time" call and specification of them must be done thru the "os9 F$STime" call.

lsttrm last terminator
cbufpt line buffer pointer
curchr current character
prevch previous character
: These FLEX locations are associated with scanning of the command line buffer. Assuming the buffer has been defined as described above, these locations have been properly defined, and the OS/9 routines which process it have been defined as described earlier, these locations should be usable in the same manner under OS/9 as under FLEX.

errtyp error type
: The error type contains the return code from the last FMS call. If it is used in a FLEX program, it should be replaced by a reference to the error code in the appropriate FCB.

ioflag special I/o flag
: FLEX programs use this location to control certain parameters of the console (specifically, to ignore the "ttyset" width and escape parameters if the location contains a non-zero value. Under OS/9, control of similar parameters may be performed (if it is necessary) thru the "os9 I$GetStt" and "os9 I$SetStt" calls. However, since this location is primarily used to help control printer devices, such parameter modification may be unnecessary since OS/9 controls the printer separately from the console.

outswt output switch
inswt input switch
foaddr file output address
fiaddr file input address
fiecho file input echo flag
: These locations are used by FLEX to control the redirection of console output to and from the console or disk files. Since OS/9 redirection is controlled from the command line, the locations cannot be used in the same manner under OS/9.

memend memory end
: This location indicates the end of the application program address space under FLEX. Since memory allocation is performed dynamically by OS/9, any usage of this location must be carefully evaluated, modified, and eliminated.

cputyp cpu type flag
: This location is logically composed of the following flags (MSB to LSB):

```
cpu_2mhz   2 mHz CPU clock rate
cpu_slow   Memory stretch active
cpu_50hz   50 Hz power line frequency
cpu_ram    CPU RAM is available
cpu_rtck   6819 real time clock available
cpu_iobx   I/O set up like old box
cpu_time   6840 timer available
cpu_xmem   Extended memory active
```

The only significant flag in this location (with respect to OS/9) is the "cpu_2mhz" flag, which is often used to help determine the timing programmatic delay loops. Since the OS/9 system is interrupt-driven, all delay loops must be carefully evaluated for possible modification.

ulcflg upper/lower case flag
: This location controls the mapping of FLEX file names from lower case to upper case or not. Case is insignificant in OS/9 path names.

verify FMS verify flag
: This location controls whether disk writes will be verified or not. Since OS/9 path descriptors determine whether or not disk writes will be verified, and the environment is so different, references to "verify" should probably be dropped.

Although they are not strictly FLEX storage locations, any access to the I/O and DAT addresses must be carefully reviewed for possible modification. Under OS/9 Level I, the I/O and DAT addresses are available for access by user programs. However, timing loops will be disrupted by the interrupt-driven nature of OS/9. Any direct access to the console port must be reviewed because OS/9 programs the port for data ready interrupts; OS/9 may read the data from the port before the program is able to read it.

Direct access to the I/O and DAT addresses is impossible under OS/9 Level 2, and must be replaced by references to standard or custom-written device drivers. This replacement is also possible, and sometimes necessary, for complex device-handling requirements, under OS/9 Level I. Such device drivers are beyond the scope of this article, but are described in the OS/9 System Programmer's Manual.

EXAMPLES

CENTRONICS RECEIVER

The first example shows a rather simple conversion of a program which inputs data from a parallel port and sends it to the FLEX console output device, which, of course, may then be redirected to disk thru the use of the "o" command.

The FLEX version of this program is as follows:

```
                    * centronics receiver for file xfer
                            opt   pag
             C003   varms   equ   $cd03      flex warm start
             CD18   outpt   equ   $cd18      flex put character
             E030   placa   equ   $e030      pia address
             0002   plaab   equ   $02        offset a=$00,b=$02
             E004   aclac   equ   $e004      acia address
C100                        org   $c100
C100 7F    E033     start   clr   placa+plaab+1 address ddr
C103 7F    E032             clr   placa+plaab ddr inputs
C106 86    34               lda   #$34       c2 out manual low
C108 B7    E033             sta   placa+plaab+1 program it
C10B B6    E033     next    lda   placa+plaab+1 check for edge
C10E 2B    09               bmi   data       yes, read it
C110 B6    E004             lda   aclac      check acia
C113 44                     lsra
C114 24    F5               bcc   next       no, loop
C116 7E    CD03             jmp   varms      exit to flex
C119 B6    E032     data    lda   placa+plaab get data
C11C B7    E032             sta   placa+plaab reset
C11F C6    3C               ldb   #$3c       c2 out manual high
C121 F7    E033             stb   placa+plaab+1
C124 C6    34               ldb   #$34       c2 out manual low
C126 F7    E033             stb   placa+plaab+1
C129 84    7F               anda  #$7f       mask parity
C12B 81    0D               cmpa  #$0d       cr
C12D 27    08               beq   output
C12F 81    20               cmpa  #$20       sp
C131 25    D8               blo   next       ignore other controls
C133 81    7F               cmpa  #$7f       del
C135 27    04               beq   next       ignore dels
C137 BD    CD18     output  jsr   outpt      output to flex
C13A 20    CF               bra   next       go back for more
                            end   start
```

An OS/9 version of this same program is as follows:

```
                          nam                   centronics receiver
                                                for os/9
                  * centronics receiver for file xfer to os/9
                          use                   /d0/defs/defsfile
0000 87CD006F             mod    endmod,name,prgrm+objct,reent+1,
                                 start,endmem
0000              stack   rmb    256            stack space
0100              endmem  equ    .              no data space
0000 46696C65     name    fcs    "Filexfer"
E030              placa   equ    $e030          pia address
0002              plaab   equ    $02            offset a=$00,b=$02
E004              aclac   equ    $e004          acia address
0015 7FE033       start   clr    placa+plaab+1 address ddr
0018 7FE032               clr    placa+plaab ddr inputs
001B 8634                 lda    #$34           c2 out manual low
001D B7E033               sta    placa+plaab+1 program it
0020 B6E033       next    lda    placa+plaab+1 check for edge
0023 2B0C    0031         bmi    data           yes, read it
0025 B6E004               lda    aclac          check acia
0028 44                   lsra
0029 24F5    0020         bcc    next           no, loop
002B CC0000               ldd    #$0000         normal exit
002E 103F06               os9    f$exit
0031 B6E032       data    lda    placa+plaab get data
0034 B7E032               sta    placa+plaab reset
0037 C63C                 ldb    #$3c           c2 out manual high
0039 F7E033               stb    placa+plaab+1
003C C634                 ldb    #$34           c2 out manual low
003E F7E033               stb    placa+plaab+1
0041 847F                 anda   #$7f           mask parity
0043 8100                 cmpa   #$0d           cr
0045 2714 005B            beq    output
0047 8120                 cmpa   #$20           sp
0049 2505 0020            blo    next           ignore other controls
```

```
0048 817F           cmpa  #$7f       del
004A 2701 0020      beq   next       ignore dels
004F 8100           cmpa  #$0d       cr
0051 2708 0058      beq   output
0053 8120           cmpa  #$20       sp
0055 25C9 0020      blo   next       ignore other controls
0057 817F           cmpa  #$7f       del
0059 27C5 0020      beq   next       ignore dels
0058 3402           pshs  a          output to os/9
005D 1f41           tfr   s,x
005F 8601           lda   #$01
0061 108E0001       ldy   #$0001
0065 103F8A         os9   i$writ
0068 3502           puls  a
006A 20B4 0020      bra   next       go back for more
006E 86F6C5         nemd
0073          endcmd equ   *
0000                end
```

Note that this conversion is valid only for OS/9 Level 1. It is not possible for a user program to access the I/O ports directly under OS/9 Level 2. However, in its limited environment, the techniques used in this converted program are valid and work quite well. It is not necessary to define device drivers and to use the other facilities of OS/9 Level 1 to access the I/O ports in a simple manner.

FILE-HANDLING CONVERSION

The second example demonstrates many of the conversions discussed earlier, primarily in terms of the file-handling aspects of FLEX. The program itself came from Leo Taylor's collection.

The FLEX version of this program is as follows:

```
                        opt    pag

                    * upper to lower case text converter
                    *
                    * this program will convert an input file of any
                    * case to an output file of lower case with the
                    * following character sequences set to upper
                    *     case:
                    *
                    * 1. any output character following a period, a
                    * question mark, or an exclamation point will be
                    * in upper case. spaces, carriage return, or line
                    * feeds between the punctuation and character
                    * will be ignored.
                    *
                    * 2. an 'i' will be upper case if preceded by a
                    * space and followed by either another space or
                    * an apostrophe.
                    *
                    * 3. the first character of a file will be
                    * upper case.
                    *
                    * program is called by: lowerc oldfile newfile.
                    *
                    * program converted by leo taylor from isi-ii
                    * program written by robert molster.
                    *
                    * flex address assignments:
                    *
               C000 flex   equ   $c000

               C840 fcb    equ   flex+$840 file control block
               C003 warms  equ   flex+$d03
               C015 getchr equ   flex+$d15
               C018 putchr equ   flex+$d18
               C01E pstrng equ   flex+$d1e
               C024 pcrlf  equ   flex+$d24
               C020 getfil equ   fl  + 2d
               C033 setext equ   flex+$d33
               C03F rpterr equ   flex+$d3f

               0403 fmscls equ   fle +$1403
               0406 fms    equ   flex+$1406

C100                       org   flex+$100

                    * program starts by opening two files

C100 20  02        lowerc bra    lower1

C102 01            vn     fcb    1          version number
C103 04            flag   fch    p          flag starts with period

               0001 a      equ   1          alpha bit of flag
               0002 i      equ   2          'i' bit
               0004 p      equ   4          '.' or '?' or '!'

C104 8E  C840      lower1 ldx   #fcb       point to fcb
C107 BD  CD2D             jsr   getfil     get the file name
C10A 25  0C               bcs   error
C10C 86  01               ldaa  #1          set for read
C10E A7  84               staa  0,x         save in fcb
C110 BD  CD33             jsr   setext     set default ext
C113 BD  D406             jsr   fms        open for read
C116 27  09               beq   lower2
C118 BD  CD3F      error  jsr   rpterr     report error
C11B BD  D403             jsr   fmscls     close all files
C11E 7E  CD03      warmsl jmp   warms      return to flex
C121 8E  C10F      lower2 ldx   #fcb2      point to fcb
C124 BD  CD2D             jsr   getfil     get file name
C127 25  EF               bcs   error
C129 86  01               ldaa  #1          set extension
C12B BD  CD33             jsr   setext
C12E 86  02               ldaa  #2          set for write
C130 A7  84               staa  0,x
C132 BD  0406             jsr   fms        open for write
C135 26  E1               bne   error
C137 8E  C840      looplow ldx   #fcb       point to read
C13A BD  0406             jsr   fms        get character
C13D 27  14               beq   readok
C13F A6  01               ldaa  1,x        check error
C141 81  08               cmpa  #8         is it eof?
C143 26  D3               bne   error
C145 8E  C10F             ldx   #fcb2      point to write
C148 B6  04               ldaa  #4         set for close
C14A A7  84               staa  0,x
C14C BD  0406             jsr   fms        close write file
C14F 26  C7        errorls bne  error
C151 20  CB               bra   warmsl     return to flex

C153 81  41        readok  cmpa  #$41       upper case?
C155 25  06               blo   lowall
C157 81  5A               cmpa  #$5a
C159 22  02               bhi   lowall
C15B 8B  20               adda  #$20       make lower

                    * all characters lower case
                    * now check flag
                    *
C15D F6  C103      lowall  ldab  flag
C160 C5  04               bitb  #p         last char period type?
C162 26  2C               bne   upper      force upper case
C164 C5  02               bitb  #i         'i' just received?
C166 26  0F               bne   geti
C168 81  69               cmpa  #$69       lower case 'i'
C16A 26  2E               bne   noflag
C16C C5  01               bitb  #a         last char alpha?
C16E 26  2A               bne   noflag
C170 CA  02               orab  #i         set 'i' flag
C172 F7  C103             stab  flag
C175 20  C0               bra   looplow    get next char

C177 81  20        geti    cmpa  #$20       space or control?
C179 2F  04               ble   ispace
C17B 81  27               cmpa  #''        apostrophe?
C17D 26  06               bne   noti
C17F 34  02        ispace  psha           save present char
C181 86  49               ldaa  #$49
C183 20  04               bra   sendi

C185 34  02        noti    psha           save present char
C187 86  69               ldaa  #$69       lower case i
C189 BD  18        sendi   bsr   write
C18B 35  02               puls            restore char
C18D 5F                   clrb            normal char
C18E 20  0A               bra   noflag     treat normally

C190 81  61        upper   cmpa  #$61       lower case?
C192 2D  06               blt   noflag
C194 81  7A               cmpa  #$7a       lower case?
C196 2E  02               bgt   noflag     greater that fc z
C198 80  20               suba  #$20       convert to upper
C19A F7  C103      noflag  stab  flag
C19D BD  00               bsr   setflag    set flags for this char
C19F BD  02               bsr   write
C1A1 20  94               bra   looplow

                    * conversion done so write character
                    *
C1A3 8E  C10F      write   ldx   #fcb2      point to write
C1A6 BD  0406             jsr   fms        write character
C1A9 26  A4               bne   errorls1
C1AB 39                   rts

                    * subroutine to set flag byte
                    *
C1AC F6  C103      setflag ldab  flag       start with old flag
C1AF 81  20               cmpa  #$20       printing char?
C1B1 2E  04               bgt   setfl      yes process
C1B3 C4  FE               andb  #$fe       clear alpha
C1B5 20  02               bra   setfl1
C1B7 C4  FB        setfl   andb  #$fb       printing char
C1B9 81  2E        setfl1  cmpa  #'.        period?
C1BB 27  08               beq   setf2
C1BD 81  3F               cmpa  #'?        question mark?
C1BF 27  04               beq   setf2
C1C1 81  21               cmpa  #'!        exclamation point?
C1C3 26  02               bne   setf3
C1C5 CA  04        setf2   orab  #p         set period type
C1C7 81  41        setf3   cmpa  #$41       alpha?
C1C9 2D  10               blt   setf5
C1CB 81  5A               cmpa  #$5a       upper case?
C1CD 2F  08               ble   setf4
C1CF 81  61               cmpa  #$61       alpha?
C1D1 2D  08               blt   setf5
C1D3 81  7A               cmpa  #$7a       lower case alpha?
C1D5 2E  04               bgt   setf5
C1D7 CA  01        setf4   orab  #a         set alpha
C1D9 C4  FB               andb  #$fb       clear p flag
C1DB F7  C103      setf5   stab  flag       new flag bits
C1DE 39                    rts

C10F               fcb2    rmb   320

                           end   lowercase
```

An OS/9 version of this same program is as follows:

```
                        nam     lowercase conversion
                         use    /d0/defs/defsfile

                      * upper to lower case text converter
                      *
                      * this program will convert an input file of any
                      * case to an output file of lower case with the
                      * following character sequences set to upper case:
                      *
                      * 1. any output character following a period, a
                      * question mark, or an exclamation point will be
                      * in upper case. spaces, carriage return, or line
                      * feeds between the punctuation and character
                      * will be ignored.
                      *
                      * 2. an 'I' will be upper case if preceded by a
                      * space and followed by either another space or
                      * an apostrophe.
                      *
                      * 3. the first character of a file will be
                      * upper case.
                      *
                      * program is called by: lowerc oldfile newfile.
                      *
                      * program converted by leo taylor from 1st-ll
                      * program written by robert meister.
                      *
0000 87 CD 00 F9              mod     endmod,namend,Prgrm+Objct,ReEnt,
                                      start,endmem

                      * program equates declared before use

0001                  vn      equ     1               version number
0001                  a       equ     1               alpha bit of flag
0002                  i       equ     2               'I' bit
0004                  p       equ     4               '.' or '?' or '!'

                      * program storage

0000                  stomem  equ     .               start of data area

0000                  flag    rmb     1               character flag

0001                  fcb     rmb     320             file control blocks
0141                  fcb2    rmb     320
0281                  inbuff  rmb     128             line buffer
0301                  lsttrm  rmb     1               last terminator
0302                  cbufpt  rmb     2               line buffer pointer
0304                  curchr  rmb     1               current character
0305                  prevch  rmb     1               previous character

0306                  endmem  equ     .               end of data area

0000 4C 6F 77 72      namend  fcs     "Lowercase"

0015                  start   equ     *               starting address

0015  34      30      lowerc  pshs    x,y             clear data area
0017  30 C4                   leax    stomem,u        clear data area
0019 108E     0306            ldy     #(endmem-stomem)
001D  6F 80           clear   clr     ,x+
001F  31 3F                   leay    -$01,y
0021  26  FA 0010             bne     clear
0023  35  30                  puls    x,y

0025  17 00D1 00F9            lbsr    initial         initialize line buffer
0028  86  04                  lda     #p              period
002A  A7 C4                   sta     flag,u          flag starts with period

                      * program starts by opening two files

002C  30 41           lower1  leax    fcb,u           point to fcb
002E  17 00C8 00F9            lbsr    getfil          get the file name
0031  25  0A 003D             bcs     error
0033  86  01                  lda     #1              set extension
0035  17 00C1 00F9            lbsr    setext          set default ext
0038  17 00BE 00F9            lbsr    fms01           open for read
003B  27  09 0046             beq     lower2
003D  17 00B9 00F9 error      lbsr    rpterr          report error
0040  17 00B6 00F9            lbsr    fmscls          close all files
0043  16 00B3 00F9 warmls     lbra    warms           return
0046  30 C9 0141    lower2    leax    fcb2,u          point to fcb
004A  17 00AC 00F9            lbsr    getfil          get file name
004D  25  EE 003D             bcs     error
004F  86  01                  lda     #1              set extension
0051  17 00A5 00F9            lbsr    setext
0054  17 00A2 00F9            lbsr    fms02           open for write
0057  26  E4 003D             bne     error
0059  30 41           loopio  leax    fcb,u           point to read
005B  17 009B 00F9            lbsr    fms00           get character
005E  27  11 0071             beq     readok
0060  A6 01                  lda     1,x             check error
0062  81  03                  cmpa    #E$EOF          is it eof?
0064  26  D7 003D             bne     error
0066  30 C9 0141              leax    fcb2,u          point to write
006A  17 008C 00F9            lbsr    fms04           close write file
006D  26  CE 003D errorl      bne     error
006F  20  02 0043             bra     warmls1         return

0071  81  41         readok   cmpa    #$41            upper case?
0073  25  06 007B              blo     lowall
0075  81  5A                  cmpa    #$5a
0077  22  02 007B              bhi     lowall
0079  8B  20                  adda    #$20            make lower

                      * all characters lower case
                      * now check flag
                      *
007B  E6 C4           lowalf  ldb     flag,u
007D  C5  04                  bitb    #p              last char period type?
007F  26  78 00AC             bne     upper           force upper case
0081  C5  02                  bitb    #i              'I' just received?
0083  26  0E 0093             bne     getI
0085  81  69                  cmpa    #$69            lower case 'i'
0087  26  20 00B6             bne     noflag
0089  C5  01                  bitb    #a              last char alpha?
008B  26  29 00B6             bne     noflag
008D  CA  02                  orb     #i              set 'I' flag
008F  E7 C4                   stb     flag,u
0091  20  06 0059             bra     loopiow         get next char

0093  81  20          getI    cmpa    #$20            space or control?
0095  2F  04 009B             ble     ispace
0097  81  27                  cmpa    #''             apostrophe?
0099  26  06 00A1             bne     notI
009B  34  02          ispace  pshs    a               save present char
009D  86  49                  lda     #$49
009F  20  04 00A5             bra     sendI

00A1  34  02          notI    pshs    a               save present char
00A3  86  69                  lda     #$69            lower case i
00A5  8D  17 00BE     sendI   bsr     write
00A7  35  02                  puls    a               restore char
00A9  5F                      clrb                    normal char
00AA  20  0A 00B6             bra     noflag          treat normally

00AC  81  61          upper   cmpa    #$61            lower case?
00AE  20  06 00B6             blt     noflag
00B0  81  7A                  cmpa    #$7a            lower case?
00B2  2E  02 00B6             bgt     noflag          greater that lc z
00B4  80  20                  suba    #$20            convert to upper
00B6  E7 C8           noflag  stb     flag,u
00B8  8D  0E 00C8             bsr     setflag         set flags for this char
00BA  8D  02 00BE             bsr     write
00BC  20  9B 0059             bra     loopiow

                      * conversion done so write character
                      *
00BE  30 C9 0141      write   leax    fcb2,u          point to write
00C2  17 0034 00F9            lbsr    fms00           write character
00C5  26  A6 006D             bne     errorls1
00C7  39                      rts

                      * subroutine to set flag byte
                      *
00C8  E6 C4           setfla  ldb     flag,u          start with old flag
00CA  81  20                  cmpa    #$20            printing char?
00CC  2E  04 00D2             bgt     setfl           yes process
00CE  C4  FE                  andb    #$fe            clear alpha
00D0  20  02 00D4             bra     setfl1
00D2  C4  FB          setfl   andb    #$fb            printing char
00D4  81  2E          setfl1  cmpa    #'.             period?
00D6  27  08 00E0             beq     setf2
00D8  81  3F                  cmpa    #'?             question mark?
00DA  27  04 00E0             beq     setf2
00DC  81  21                  cmpa    #'!             exclamation point?
00DE  26  02 00E2             bne     setf3
00E0  CA  04          setf2   orb     #p              set period type
00E2  81  41          setf3   cmpa    #$41            alpha?
00E4  20  10 00F6             blt     setf5
00E6  81  5A                  cmpa    #$5a            upper case?
00E8  2F  08 00F2             ble     setf4
00EA  81  61                  cmpa    #$61            alpha?
00EC  20  08 00F6             blt     setf5
00EE  81  7A                  cmpa    #$7a            lower case alpha?
00F0  2E  04 00F6             bgt     setf5
00F2  CA  01          setf4   orb     #a              set alpha
00F4  C4  FB                  andb    #$fb            clear p flag
00F6  E7 C4           setf5   stb     flag,u          new flag bits
00F8  39                      rts

                      *
                      * the following entry points would be replaced
                      * by the code described in an earlier section;
                      * it is not included here to avoid repitition.
                      *

00F9                  initia  equ     *               initialize line buffer
00F9                  warms   equ     *               return to flex
00F9                  getfil  equ     *               get file specifications
00F9                  setext  equ     *               set file extension
00F9                  rpterr  equ     *               report error

00F9                  fmscls  equ     *               close files
00F9                  fms00   equ     *               get/put next character
00F9                  fms01   equ     *               open input
00F9                  fms02   equ     *               open output
00F9                  fms04   equ     *               close

00F9                  endmod  equ     *
0015                          end     lowercase
```

BUFFERED SEQUENTIAL I/O

The third example demonstrates a scheme for implementing buffered sequential I/O using OS/9 system requests, with the goal of optimizing program performance in many I/O-bound programs.

Since every call to OS/9 from a module executing under its control causes an interrupt, and interrupts contribute heavily to system overhead, it would seem logical to attempt to significantly reduce the

number of OS/9 calls in order to reduce the system overhead required to process a module.

In I/O-bound portions of modules involving significant amounts of sequential I/O, the easiest manner in which to reduce the number of calls to OS/9 is to request that more than one byte at a time be transferred between the module and OS/9 during sequential I/O operations. Every OS/9 call not performed is at least 35 machine cycles saved, just for the "swi2" and "rts" instructions, not counting the OS/9 overhead, which probably accounts for hundreds or thousands more instuctions per call, so the savings may be great.

The skeletal module listed below contains several potentially useful routines which implement a form of buffered sequential I/O under OS/9. They are loosely based upon a earlier set of similar routines provided in TSC's Uniflex Programmer's Guide, and are used heavily in CSC products to increase performance.

The routines in the sample module below are as follows:

initbuf	initialize buffers demonstrates how to initialize buffer control areas; re-opening files requires reinitializing them.
getbuf	get character from buffer returns next character, reloading buffer if needed.
putbuf	put character into buffer outputs next character, dumping buffer if needed.
clsbuf	close output buffer dumps used portion of output buffer if not empty; must be called before output file is closed.

Associated with the routines is a control area for each buffer. The comments associated with the definitions of the offsets indicate the usage of each field in each control area. The first few items in each control area are analogous to items in the FLEX FCB, and are indicated as such. Thus, these routines could fit in well in the case of programs being converted from FLEX to the OS/9 file environment.

```
                                nam     buffered I/O routines
                                use     /d0/defs/defsfile
0000 87 CD 01 4C                mod     endmod,name,PrgrmObjct,ReEnt,
                                        start,endmem
                        **
0000                    bufffb  equ     0       FCB function code
0 1                     buffer  equ     1       FCB error code
0 2                     buffac  equ     2       FCB activity status
0003                    buffpn  equ     3       FCB path number
0004                    buffre  equ     4       edited/raw function code
0005                    buffbp  equ     5       buffer pointer
0007                    buffcp  equ     7       character pointer
0009                    buffbl  equ     9       buffer length
000B                    buffnc  equ     11      character counter
                        **
0010                    conlen  equ     16      length of control area
0020                    fnmlen  equ     32      length of path name
0100                    buflen  equ     256     length of buffer
                        **
0001                    read    equ     1       read buffer raw
0002                    readln  equ     2       read buffer edited
0003                    write   equ     3       write buffer raw
0004                    writln  equ     4       write buffer edited
                        **
0000                    stamem  equ     .       start of data area
                        **
0000                    inpath  rmb     fnmlen  input path name
0020                    incont  rmb     conlen  input path controls
0030                    inbuff  rmb     buflen  input buffer
0130                    otpath  rmb     fnmlen  output path name
0150                    otcont  rmb     conlen  output path controls
0160                    otbuff  rmb     buflen  output buffer
0260                    ticont  rmb     conlen  terminal input controls
0270                    tibuff  rmb     buflen  terminal input buffer
0370                    tocont  rmb     conlen  terminal output controls
0380                    tobuff  rmb     buflen  terminal output buffer
                        **
0480                    endmem  equ     .       end of data area
                        **
0000 42 75 66 66        name    fcs     "Buffer"
                        **
                        ****************************
                        **
0013                    start   equ     *       starting address
                        **
0013  30 C4                     leax    stamem,u  clear buffers
0015 10BE    0480               ldy     #(endmem-stamem)
0019  6F 80             clear   clr     ,x+
001B  31 3F                     leay    -$01,y
001D  26  FA 0019               bne     clear
                        **
001F  17 00C7 00E9              lbsr    initbuf   initialize buffers
                        **
                        **  program logic goes here
                        **  ------- ----- ---- ----
                        **
0022 103F       06              os9     F$Exit    exit program
                        *
                        **
                        ****************************
                        **
                        * getbuf   gets character from buffer
                        *
                        * requires  x=buffer pointer
                        *
                        * returns   cc if no error
                        *           cs if error, b=error
                        *           vs if eof
                        *           if all OK, a=character
0025  34       64       getbuf  pshs    b,y,u
0027  EC 0B                     ldd     buffnc,x  characters in buffer
0029  26  20 0058               bne     getbne
002B  A6 03                     lda     buffpn,x  path number
002D 10AE 09                    ldy     buffbl,x  buffer length
0030  E6 04                     ldb     buffre,x  function code
0032  34       10               pshs    x
0034  AE 05                     ldx     buffbp,x  buffer address
0036  C1       02               cmpb    #readln
0038  26  09 003F               bne     getbrw
003A 103F       BB              os9     I$ReadLn  reload buffer edited
003D  20  0A 0049               bra     getbrd
003F  4D                getbrw  tsta              check for terminal read
0040  26  04 0046               bne     getbrt
0042 108E    0001               ldy     #$0001    one byte only
0046 103F       8B      getbrt  os9     I$Read    reload buffer raw
0049  35       10       getbrd  puls    x
004B  25  1F 006C               bcs     getber    check for error return
004D 10AF 0B                    sty     buffnc,x  update character counter
0050  27  16 0068               beq     getbef    check for eof
0052  EC 09                     ldd     buffbp,x  reset character pointer
0054  E0 07                     subd    buffcp,x
0056  EC 0B                     ldd     buffnc,x  update character counter
0058  83    0001      getbne    subd    #$0001    count characters
005B  E0 0B                     stb     buffnc,x
005D 10AE 07                    ldy     buffcp,x
0060  A6 A0                     lda     ,y+
0062 10AF 07                    sty     buffcp,x  update character pointer
0065  5F                        clrb              cc, vc
0066  35       E4               puls    b,y,u,pc
0068  1A       02      getbef  orcc    #$02      vs for eof
006A  35       E4               puls    b,y,u,pc
006C  C1       03      getber  cmpb    #E$EOF    check for eof
006E  27  F8 0068               beq     getbef
0070  1A       01               orcc    #$01      cs
0072  32 61                     leas    $01,s
0074  35       E0               puls    y,u,pc    cs, b=error
                        **
                        * putbuf   puts character into buffer
                        *
                        * requires  x=buffer pointer
                        *           a=character
                        *
                        * returns   cc if all OK
                        *           cs if error, b=error
                        **
0076  34       66       putbuf  pshs    d,u,y
0078  EC 0B                     ldd     buffnc,x  characters in buffer
007A  26  21 009D               bne     putbne
007C  A6 03                     lda     buffpn,x  path number
007E  E6 04                     ldb     buffre,x  function code
0080 10AE 09                    ldy     buffbl,x  buffer length
0083  34       10               pshs    x
0085  AE 05                     ldx     buffbp,x  buffer address
0087  C1       04               cmpb    #writln
0089  26  09 0090               bne     putbrw
008B 103F       8C              os9     I$WritLn  dump buffer edited
008E  20  03 0093               bra     putbwt
0090 103F       8C      putbrw  os9     I$Write   dump buffer raw
0093  35       10       putbwt  puls    x
0095  25  17 00AE               bcs     putber    check for error
0097  EC 09                     ldd     buffbp,x  update character pointer
0099  E3 07                     std     buffcp,x
009B  EC 09                     ldd     buffbl,x  update buffer length
009D  83    0001      putbne    subd    #$0001    count chars
00A0  E0 0B                     stb     buffnc,x  update character count
00A2 10AE 07                    ldy     buffcp,x
00A5  35       02               puls    a
00A7  A7 A0                     sta     ,y+
00A9 10AF 07                    sty     buffcp,x  update character pointer
00AC  35       A4               puls    b,y,pc
00AE  35       20       putber  puls    y
00B0  4F                        clra
00B1  1A       01               orcc    #$01      cs, error
00B3  35       E0               puls    y,u,pc    cs, b=error
                        **
                        * clsbuf   closes output buffer
                        *
                        * requires  x=buffer pointer
                        *
                        * returns   cs if error, b=error
                        **
00B5  34       66       clsbuf  pshs    d,u,y
00B7  EC 09                     ldd     buffbl,x  characters in buffer
00B9  A3 0B                     subd    buffnc,x
00BB  27  1E 00DB               beq     clsbwt
00BD  1F  02                    tfr     d,y       character count
00BF  A6 03                     lda     buffpn,x  path number
00C1  E6 04                     ldb     buffre,x  function code
00C3  34       10               pshs    x
00C5  AE 05                     ldx     buffbp,x  buffer pointer
00C7  C1       04               cmpb    #writln
00C9  26  09 00D0               bne     clsbrw
00CB 103F       8C              os9     I$WritLn  dump buffer edited
00CE  20  03 00D3               bra     clsbwt
00D0 103F       8C      clsbrw  os9     I$Write   dump buffer raw
00D3  35       10       clsbwt  puls    x
00D5  25  0B 00E2               bcs     clsber    check for error return
00D7  EC 05                     ldd     buffbp,x  update character pointer
00D9  ED 07                     std     buffcp,x
00DB  EC 09              clsbem ldd     buffbl,x  buffer size
00DD  ED 0B                     std     buffnc,x  update character counter
00DF  4F                        clra
00E0  35       E6               puls    d,y,u,pc
00E2  35       20       clsber  puls    y
00E4  4F                        clra
00E5  1A       01               orcc    #$01      cs, error
00E7  35       E0               puls    y,u,pc    cs, b=error
```

```
                         **
                         * inibuf  initializes buffers
                         **
00E9   86       01      inibuf lda    #read         set up buffers
00EA   A7 C8    24             sta    incont+buffre,u
00EE   A7 C9 0264              sta    ticont+buffre,u
00F2   86       03             lda    #write
00F4   A7 C9 0154              sta    otcont+buffre,u
00F8   86       04             lda    #writln
00FA   A7 C9 0374              sta    tocont+buffre,u
00FE   CC     0100             ldd    #buflen
0101   ED C9 0269              std    ticont+buffbl,u
0105   ED C9 0379              std    tocont+buffbl,u
0109   ED C9 0377              std    tocont+buffcp,u
010D   ED C8    29             std    incont+buffbl,u
0110   ED C9 0159              std    otcont+buffbl,u
0114   ED C9 0157              std    otcont+buffcp,u
0118   86       01             lda    #$01
011A   E7 C9 0373              stb    tocont+buffpn,u
011E   30 C8    30             leax   inbuff,u
0121   AF C8    25             stx    incont+buffbp,u
0124   AF C8    27             stx    incont+buffcp,u
0127   30 C9 0160              leax   otbuff,u
012B   AF C9 0155              stx    otcont+buffbp,u
012F   AF C9 0157              stx    otcont+buffcp,u
0133   30 C9 0270              leax   tibuff,u
0137   AF C9 0265              stx    ticont+buffbp,u
013B   AF C9 0267              stx    ticont+buffcp,u
013F   30 C9 0380              leax   tobuff,u
0143   AF C9 0375              stx    tocont+buffbp,u
0147   AF C9 0377              stx    tocont+buffcp,u
014B   39                      rts
                         **
014C                    endmod equ    *
0000                           end
```

MEDIA CONVERSION

The physical conversion of programs from FLEX to OS/9 is made materially more difficult by the fact that neither can logically read or write the other's diskettes. Both use 256-byte data segments with (potentially) the same disk interface hardware. Unfortunately, the disk directory and identification sector formats are quite different and incompatible.

Until recently, the only reliable means of converting media from FLEX to OS/9 (or vice versa) has been the use of two systems with communications facilities, either physically hard-wired together or remote over modem.

The OF program, distributed by Data-Comp, partially solves this problem. It utilizes a split format diskette, which appears to FLEX to be its diskette, and to OS/9 to be its OS/9 diskette. A BASIC09 program provides the disk formatting and OS/9 interface, whereas standard FLEX utilities provide the necessary FLEX interface. Using this technique, two systems (or one system alternating between FLEX and OS/9) are still required to perform the conversion of programs and data between the operating systems. Arbitrary FLEX diskettes may still not be directly converted to OS/9, and vice versa. However, within the restrictions just discussed, OF is quite effective, and a great improvement over modem.

SUMMARY

This article attempted to provide a structure for the conversion of application programs intended for execution under the FLEX operating system to operation under the OS/9 operating system.

It discussed the additional requirements on programs running under OS/9, and provided equivalents for many FLEX entry points and storage locations commonly used by application programs.

It provided two examples of program conversions and one example of a program optimization scheme intended to enhance the performance of converted I/O-bound programs.

It discussed the problems of transporting the program and data files from OS/9 to FLEX and suggested several solutions.

With this information, a programmer generally familiar with assembler languages for both OS/9 and FLEX should be able to readily convert programs from FLEX to OS/9.

BIT BUCKET

```
EDITOR'S NOTE:  PLEASE NOTE THAT THIS PROGRAM
IS ALSO ON THE 68 MICRO JOURNAL BBS.  THOSE NOT
WISHING TO TYPE IN THE CODE MAY DOWNLOAD FROM
THE BBS.

ALSO PLEASE NOTE THAT THE SYMBOL '@' DENOTES THE
'ESC' FUNCTION.

 NAM MODEM
*
*
*       MODEMPROGRAM      for ACIA 6850. CPU 6809.
*       and    FLEX dos
*
*       Both ACIA's have to be wired for IRQ !
*
*       JUNE 1982
*       Written by Esko Antikainen ( SM3AKP )
*                  and Avo Kask ( SM0KYO )
*
*       Modified extensively by Steven M. Ward on 07 FEB 83.
*
*       Version number change is from version 2 to version 3.
*
*
*       The following changes were made:
*
*       1) Added CENAINT, CDISINT, MENAINT, MDISINT to simplify
*          adaptation.  These constants set up the console and modem
*          ACIA's including baud divide rates, interrupts enabled or
*          disabled, etc.  Change these constants to suit your system.
*       2) Corrected problems in program so that text files are saved
*          with <CR> as the line delimiter; linefeeds, nulls, deletes,
*          etc. are stripped.  Only $00, $0C, and $20-$7E can be
*          stored in the receive buffer or sent to the remote host from
*          a diskfile.  Any code can be sent from the keyboard to the
*          remote host except the menu command codes.
*       3) Corrected problem of program double-spacing the terminal
*          text when also placing text in the receive buffer. (this
*          happened when remote host supplied a <CRLF> as the line
*          terminator, which is normally the case.)
*       4) Changed the command prompts slightly to avoid conflict with
*          commonly needed control codes such as X-ON, X-OFF.
*       5) Added X-ON, X-OFF handshaking response to the @T diskfile
*          transmission function such that this program will now honor
*          remote host X-ON, X-OFF commands.
*       6) To adapt this program for a particular FLEX9 system only the
*          MODEM, TERMIN, and IRQVEC equates need be changed.  Also, the
*          ENAINT and DISINT values may need to be changed as well.  All
*          other equates, constants, etc. should not need to be changed
*          for FLEX9 unless you have made custom changes to standard
*          FLEX9.
*        7) Be aware that some labels have more than six characters and
*          if your assembler has problems, check and change these longer
*          labels before panicking!
*
*
*       SYSTEM   EQUATES
*
TERMOUT EQU     $C018   FLEX CHARACTER OUTPUT
WARMS   EQU     $CD03
PSTRNG  EQU     $CD1E
MODEM   EQU     $F7E0   MODEMPORT (ACIA) ***MODIFY AS NEEDED***
TERMIN  EQU     $F7E8   TERMINALPORT (ACIA) ***MODIFY AS NEEDED***
IRQVEC  EQU     $F5C8   ADDRESS TO MY IRQ ROUTINE ***MODIFY AS NEEDED***
INBUFF  EQU     $CD1B
SETEXT  EQU     $CD33
GETFIL  EQU     $CD2D
FMSCLS  EQU     $D403
FMS     EQU     $D406
FCB     EQU     $C840
RPTERR  EQU     $CD3F
PCRLF   EQU     $CD24
MEMEND  EQU     $CC2B
XON     EQU     $11
XOFF    EQU     $13
*
        ORG     $0000
*
START   BRA     STARTO
        FCB     3       VERSION NUMBER
*
*       SYSTEM  CONSTANTS ( adapt to your system )
*
ECHO    FCB     5       @E ECHO ON/OFF
TRANSM  FCB     $14     @T SEND  DISKFILE
SAVE    FCB     $12     @R SAVE TEXT ON RECEIVE
WRITE   FCB     $17     @W WRITE RECEIVED TEXT TO DISK-
RETUR   FCB     $06     @F RETURN TO FLEX
ESCAPE  FCB     $0E     @N NEW (RESET )
IRQSAV  RMB     2       SAVE SYSTEM IRQVECTOR
ECFLG   FCB     0       ECHO ON-FF. OFF=00
POINTER FDB     BUFSTA
SAVFLO  FCB     $FF     0=SAVE RECEIVED TEXT-
ACIARE  FDB     TERMIN+1
ACIACR  FDB     TERMIN
MODARE  FDB     MODEM+1
MODCR   FDB     MODEM
WAITFL  FCB     $00
*
** MODIFY THE NEXT TWO CONSTANTS TO MATCH YOUR SYSTEM
*
MENAINT FCB     $99     ENABLED INTERRUPTS; 8 DATA, 1 STOP BITS; X16
MDISINT FCB     $15     DISABLED INTERRUPTS; 8 DATA, 1 STOP BITS; X16
CENAINT FCB     $96     ENABLED INTERRUPTS; 8 DATA, 1 STOP BITS; X64
CDISINT FCB     $16     DISABLED INTERRUPTS; 8 DATA, 1 STOP BITS; X64
*
TEROUT  JMP     TERMOUT FLEX OUTPUT ROUTINE
*
STARTO  LDX     IRQVEC
        STX     IRQSAV  SAVE SYSTEM IRQVECTOR
        LDX     #INTER
        STX     IRQVEC  INTERRUPTROUTINE
        LDA     #3      ACIA MASTER RESET
        STA     [ACIACR]
        STA     [MODCR]
START1  LDA     CENAINT ENABLE CONSOLE INTERRUPT
        STA     [ACIACR]  SET UP BOTH ACIAS
        LDA     MENAINT ENABLE MODEM INTERRUPT
        STA     [MODCR]
        LDA     [ACIARE] DUMMY READ RESET IRQ-FLAG
        LDA     [MODARE]  "
        LDX     #STATXT DISPLAY MENU
        JSR     PSTRNG
        JSR     PCRLF
LOOP    CWAI    #%11101111 ENABLE IRQ
        BRA     LOOP
DISFIL  LDX     #DISTXT ROUTINE FOR SENDING DISKFILE
        JSR     PSTRNG
        LDB     CDISINT DISABLE CONSOLE INTERRUPT
        STB     [ACIACR] NO IRQ FROM KEYBOARD
        JSR     INBUFF INPUT FILENAME
        JSR     PCRLF
        LDB     CENAINT
        STB     [ACIACR] IRQ AGAIN
        LDX     #FCB
        JSR     GETFIL
        LBCS    ERROR
        LDA     #1      EXT=TXT
        JSR     SETEXT
        LDA     #1
        STA     ,X
        JSR     FMS     OPEN READ
        LBNE    ERROR
RELOOP  JSR     FMS     GET CHR
        LBNE    ERROR
        ANDA    #$7F
        CMPA    #$1F
        BHI     RLOOP2
        CMPA    #$0D
        BEQ     RLOOP3
```

```
152.00=         CMPA    #$0C
153.00=         BEQ     RLOOP3
154.00=         BRA     RELOOP
155.00=RLOOP2   CMPA    #$7F
156.00=         BEQ     RELOOP
157.00=RLOOP3   TST     EFLG
158.00=         BEQ     LOP
159.00=         JSR     TEROUT   OUTPUT TO TERMINAL
160.00=         CMPA    #$0
161.00=         BNE     LOP
162.00=         LDA     #$A
163.00=         JSR     TEROUT   OUTPUT A LINE FEED
164.00=         LDA     #$0
165.00=LOP      LDB     [MODCR]
166.00=         ANDB    #$00000010
167.00=         BEQ     LOP      NOT READY YET
168.00=WAIT     LDB     WAITFL
169.00=         CMPB    #$00
170.00=         BNE     WAIT
171.00=         STA     [MODARE]
172.00=         BRA     RELOOP
173.00=WRIOIS   LDX     #WRITXT WRITE TEXT TO DISK
174.00=         JSR     PSTRNG
175.00=         LDB     CDISINT
176.00=         STB     [ACIACR] NOT TERMINAL IRQ
177.00=         JSR     INBUFF
178.00=         LDB     CENAINT
179.00=         STB     [ACIACR] TERMINAL IRQ AGAIN
180.00=         LDX     #FCB
181.00=         JSR     GETFIL
182.00=         LBCS    ERROR
183.00=         LDA     #1
184.00=         JSR     SETEXT   EXT=.TXT
185.00=         LDA     #2
186.00=         STA     ,X
187.00=         JSR     FMS      OPEN FOR WRITE
188.00=         LBNE    ERROR
189.00=         LDY     #BUFSTA
190.00=WLOP     CMPY    POINTER
191.00=         BEQ     WSTOP
192.00=         L A     ,Y+
193.00=         JSR     FMS      WRITE TO DISK
194.00=         LBNE    ERROR
195.00=         BRA     WLOP
196.00=WSTOP    LDA     #4
197.00=         STA     ,X
198.00=         JSR     FMS      CLOSE FILE
199.00=         LBNE    ERROR
200.00=         LDX     #BUFSTA
201.00=         STX     POINTER  CLEAR BUFFER
202.00=         JMP     START3
203.00=EXIT     LDA     #3 MASTER RESET ACIA
204.00=         STA     [ACIACR]
205.00=         LDA     CDISINT SETUP NORMAL CONSOLE CONFIGURATION ********
206.00=         STA     [ACIACR]
207.00=         LDX     IRQSAV
208.00=         STX     IRQVEC   RESET SYSTEM IRQ
209.00=         JMP     WARMS
210.00=ESCA     JSR     FMSCLS   CLOSE OPEN FILES
211.00=         LDA     #$FF
212.00=         STA     SAVFLG   DO NOT SAVE TEXT ON RECEIVE
213.00=         LDA     #$00
214.00=         STA     WAITFL
215.00=         LDX     #BUFSTA
216.00=         STX     POINTER  RESET TEXTPOINTER
217.00=         JMP     START1   JUMP TO NORMAL RECEIVE ROUTINE
218.00=INTER    LDB     [MODCR]
219.00=         BPL     CHRIN
220.00=         LDA     [MODARE]
221.00=         ANDA    #$7F     STRIP PARITY
222.00=         CMPA    #XOFF
223.00=         BNE     INTER2
224.00=         LDB     #$FF
225.00=         STB     WAITFL
226.00=         RTI
227.00=INTER2   CMPA    #XON
228.00=         BNE     LINEF
229.00=         LDB     #$00
230.00=         STB     WAITFL
231.00=         RTI
232.00=LINEF    CMPA    #$0A
233.00=         BNE     BELL
234.00=         JSR     TEROUT
235.00=         RTI
236.00=BELL     CMPA    #$07
237.00=         BNE     INTER3
238.00=         JSR     TEROUT
239.00=         RTI
240.00=INTER3   CMPA    #$0D
241.00=         BEQ     INTER9
242.00=         CMPA    #$0C
243.00=         BEQ     INTER5
244.00=         CMPA    #$1F
245.00=         BHI     INTER4
246.00=         RTI
247.00=INTER4   CMPA    #$7F
248.00=         BNE     INTER9
249.00=         RTI
250.00=INTER9   JSR     TEPOUT
251.00=         TST     SAVFLG
252.00=         BNE     RTI
253.00=         LDX     POINTER
254.00=         CMPX    MEMEND
255.00=         BEQ     WRISTO   MEMORY FULL
256.00=         STA     ,X+
257.00=         STX     POINTER
258.00=         BRA     INTER
259.00=WRISTO   LDX     #FULTXT MEMORY FULL
260.00=         JSR     PSTRNG
261.00=         LDX     #START1  NEW RETURNADDRESS
262.00=         STX     10,S
263.00=         RTI
264.00=CHRIN    LDB     [ACIACR] CHARACTER INPUT HANDLER
265.00=         BPL     RTI
266.00=         LDA     [ACIARE] GET CHAR
267.00=         ANDA    #$7F STRIP PARITY
268.00=         CMPA    #ETX RETURN TO FLEX ?
269.00=         BEQ     RET
270.00=         CMPA    #ECHO ECHO ON/OFF ?
271.00=         BEQ     EKOSET
272.00=         CMPA    #SAVE SAVE TEXT ?
273.00=         BEQ     SAVSET
274.00=         CMPA    #TRANSM TRANSMIT TEXT ?
275.00=         BEQ     TRANIT
276.00=         CMPA    #WRITE WRITE TO DISK ?
277.00=         BEQ     DISWRI
278.00=         CMPA    ESCAPE START ALL OVER AGAIN ?
279.00=         BEQ     ESCAP
280.00=         TST     EFLG     ECHO ??
281.00=         BEQ     RTI
282.00=         JSR     TEROUT   CHARACTER TO TERMINAL
283.00=OUT      LDB     [MODCR]
284.00=         ANDB    #$00000010
285.00=         BEQ     OUT
286.00=         STA     [MODARE]
287.00=RTI      RTI
288.00=RET      LDX     #EXIT
289.00=         STX     10,S     NEW RETURNADDRESS
290.00=         RTI
291.00=EKOSET   COM     EFLG
292.00=         BRA     RTI
293.00=SAVSET   CLR     SAVFLG
294.00=         LDX     #SAVTXT
295.00=         JSR     PSTRNG
296.00=         JSR     PCRLF
297.00=         LDX     #BUFSTA
298.00=         STX     POINTER  CLEAR THE BUFFER
299.00=         RTI
300.00=TRANIT   LDX     #DISFIL
301.00=         STX     10,S     NEW RETURNADDRESS
302.00=         RTI
303.00=DISWRI   LDX     #WRIOIS
304.00=         STX     10,S     NEW RETURNADDRESS
305.00=         RTI
306.00=ESCAP    LDX     #ESCA
307.00=         STX     10,S     NEW RETURNADDRESS
308.00=         RTI
309.00=ERROR    LDA     1,X      ERROR BYTE
310.00=         CMPA    #8
311.00=         BNE     STOP
312.00=         LDA     #4
313.00=         STA     ,X
314.00=         JSR     FMS      CLOSE FILE
315.00=         LDA     1,X
316.00=         BNE     STOP
317.00=         LDX     #REDTXT
318.00=         JSR     PSTRNG
319.00=         JSR     PCRLF
320.00=         JMP     START1
321.00=STOP     JSR     RPTERR
322.00=         JSR     FMSCLS
323.00=         LDA     #$00
324.00=         STA     WAITFL
325.00=         JMP     START1
326.00=FULTXT   FCC     /Memory full !!/
327.00=         FCB     $07,$04
328.00=DISTXT   FCC     /Name of diskfile to transfer ? /
329.00=         FCB     $04
330.00=REDTXT   FCC     /Transmission done/
331.00=         FCB     $07,$04
332.00=STATXT   FCB     $D,$A,$A
333.00=         FCC     /@T = Transmit File/
334.00=         FCB     $D,$A
335.00=         FCC     /@R = Save Text/
336.00=         FCB     $D,$A
337.00=         FCC     /@W = Write Text to Diskfile/
338.00=         FCB     $D,$A
339.00=         FCC     /@E = Echo On-Off Toggle (half or full duplex)/
340.00=         FCB     $D,$A
341.00=         FCC     /@N = New; clear receive buffer and restart/
342.00=         FCB     $D,$A
343.00=         FCC     /@F = Return to Flex/
344.00=         FCB     $D,$A,$A
345.00=         FCC     /Now in conversational mode; "Save Text" is Off/
346.00=         FCB     $D,$A,$A,$4
347.00=SAVTXT   FCC     /Saving text into buffer /
348.00=         FCB     $04
349.00=WRITXT   FCC     /Write saved text to disk. FILENAME ? /
350.00=         FCB     $04
351.00=BUFSTA   RMB     1        START OF BUFFER
352.00=         END     START
```

MICROWARE.

PRESS RELEASE

September 15, 1983
For Immediate Release
Contact: Andy Ball, 515-279-8844

RMA RELOCATABLE MACRO ASSEMBLER INTRODUCED BY MICROWARE

Microware has introduced RMA, a powerful new full feature relocatable assembler and linkage editor for the OS-9 Operating System. RMA was designed to process both manually-written and compiler-generated assembly language programs with special features specifically designed for the OS-9 environment.

Sections of assembly language programs can be independently assembled to "relocatable object files". The linkage editor takes any number of relocatable object files and/or library sections and combines them into a single executable OS-9 program. The linker can optionally generate a detailed load map listing.

RMA has special facilities for convenient generation of position-independent and reentrant programs. For example, global data variables (including indexed and direct addressing modes commonly used in OS-9 programs) and program references are automatically processed properly.

The macro facility permits commonly used instruction sequences to be defined once, then used within the program as often as desired with automatic parameter substitution. Conditional assembly functions permit only specified sections of the program to be assembled. This can be used to produced various customized versions of a program for a single master source file.

Dear Don,

In the July 83 issue, you published my program called "RADCAT", a small data management system. An oversight on my part, which was pointed out by a few readers in personal correspondence, is the inability of the program to handle parallel printers. Also included in the program was a non standard I/O call to the MEKIM[illegible] firmware monitor, which, not surprisingly, left a few systems cold in their tracks (no pun intended).

The above mentioned problems have now been cured, along with an additional enhancement which amounts to being able to redirect the output to either the terminal or printer on all functions. The printer cure amounts to loading (automatically), and vectoring all printer output through the PRINTER.SYS drivers. Also the addition of being able to specify which drive the data files reside was added.

Another problem, which is not really a problem, but more of an irritation, is the fact that RADCAT uses lowercase characters in the disk data file specifications. This provides a sort of file protection in that Flex normally does not recognize lowercase characters and makes the files virtually impossible to delete. If an attempt at deleting the data file is made, Flex will return a "NON "OUNT" error. This problem (irritation) has not been resolved, however it can be cured by changing all occurences of "Catalog" to "CATALOG" in the source file and re assembling into a .CMD file. While in the Flex editor (editing RADCAT), use the command sequence: ♦PrC/Catalog/CATALOG/1000. Also, it may be advisable to eliminate the modification to Flex's eapup in the beginning of the program.

Again, as in the original article, if anyone needs help, please feel free to contact me. Please include a disk (with other software you wish to share if possible), and sufficient return postage, and I will return the updated source file and an assembled .CMD file.

Robert Lund
P.O. Box 806
Hillside, IL. 60162

Robert M. Morrison
RSU #1, Box 912
Alfred, ME 04002
Tel. (207) 49 6103 ext 363

October 20, 1983

'68' Micro Journal
P.O. Box 849
Hixson, TN 37343

Dear Don,

I have some comments about the article entitled "SELECTIVE DIR.CMD" by Loren Gitelson in the September 1983 issue (Volume V, Issue IX) of '68' Micro Journal.

You may have to refresh my memory because it has been a long time since my system has been fully operational (due to a signal in my move here to Frankfurt, Germany from Kalamazoo City, Oklahoma, but I believe that all versions of FLEX include the DIR command. Although this command is not quite as versital as the DIRE command written by Mr. Gitelson, it does provide most of the capabilities that the author claims was lacking in FLEX. To use his example of DIRE e.b*, the same listing could be obtained by using the command DIR .B*. His second example, DIRE FILE?.TXT could be simply DIR FILE.TXT using the FLEX provided DIR command.

My purpose in writing is definately NOT to belittle Mr. Gitelson! On the contrary, his program has some very desirable additional features that do not exist in the normal DIR command: specifically, the ability to list all text files ending in CLOCK to using the command DIR *CLOCK.TXT. In addition, he has added some very nice printer control features to make the printed output much more readable.

I mention this because of my hatred of time wasted spent re-inventing the wheel. This is one of the greatest benefits that I get from your magazine -- the exchange of ideas that occurs between the readers. I can only wonder if Mr. Gitelson would have spent the time writing DIRE if he already had a copy of DIR (I assume that he didn't know of its existance based on the first paragraph in his article)? If so, I hope that it was for the few additional capabilities in DIRE. I believe DIR to be a fine utility, but I think that $49.95 is somewhat outragous to pay for a copy of the source code!! Even if DIR did not exist this would be an excessive amount to pay.

Along the line of preventing duplication of work, I am working on converting SASCA I to 6809 code. If anyone is interested in assisting in this project, or has already done some work in this area, please call or write me.

Sincerely,

Robert M. Morrison

Dear Folks;

I did a very foolish thing by letting my '68 MJ subscription lapse. Reading endless inane articles ("make a pretty snowflake with COCO!", "stop the deadly pizza's with Color Astro Chomp!") and gushing, simplistic, uninformed, and invariably-dead-wrong reviews, I've come to appreciate Computer Publishing's Editorial Policies. I personally find 68 MJ more useful and informative than the C.C. dedicated magazines. But, then again, I haven't yet subscribed to Color M.J. Please find enclosed a check for $40 ($16.50+$24.50) to start a subscription of Color M.J., and renew 68 MJ. This will probably get to you after you've shipped, but if you could begin these subscriptions with the current issues, GREAT!

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COMPILER EVALUATION SERVICES
By: Ron Anderson

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Due to the constant and rapid updating and enhanchment of numerous compilers, and the different utility, appeal, speed, level of communication, memory usage, etc., of different compilers, the following services are now being offered with periodic updates.

This service, with updates, will allow you who are wary or confused by the various claims of complier vendors, an opportunity to review comparisons, comments, benchmarks, etc., concerning the many different compilers on the market, for the 6809 microcomputer. Thus the savings could far offset the small cost of this service.

Many have purchased compliers and then discovered that the particular compiler purchased either is not the most efficient for their purposes or does not contain features necessary for their application. Thus the added expense of purchasing additional compiler(s) or not being able to fully utilize the advantages of high level language compilers becomes too expensive.

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HELP

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Please drop me a line and tell me your name, address, and price per item.
My system is a 6800/SWTBUG/SS-50/SS-30 with Percom LFD 400.

Lennart Billgren
Soderleden 5
S 582 57 Linkoping Sweden

•••

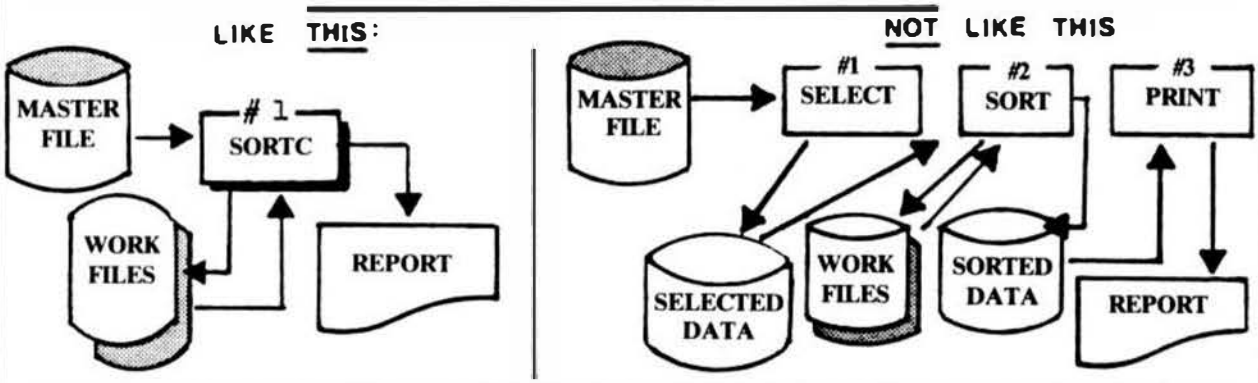
Dear Mr. Williams:
I am really convinced that your Journal is the best source of information for 68XX(X) products and applications.
I would like to know if you have some information about thee following topics;
1) Does it exist some formal 6809/68000 User Group in order to join efforts and save time, in the USA? I mean, if we could receive regularly 'standard-common' application routines (Assembler) on math, statistics, control, Op. Systems techniques, etc?
2) Has some of your subscribers written a Fast Fourier Transform routine for 6809/6800 (or Z80)? I would like to contact him, to interchange applications idees.
3) Has some of your subscribers worked with the Extended Addressing for the SSB (6809 SC8-69, SS50C) system? I will appreciate him publishing a small *sample* routine accesing and running a program (assembler) on any address greater than 64K.
I would like that your magazine include gradually more 68000 information and application programs, I hope not bothering you with these questions.

Sincerely yours,
Prof Geza Holzhaker
Universidad de los Andes
Apdo Correos 454 Merida
Edo Merida Venezuela

•••

SORTC** for OS9*

THE ONE AND ONLY



BOLDLY GOING WHERE NO SORT HAS GONE BEFORE

SORTC is a high speed, full-record compounding disk sort, which gives microcomputer users mainframe capabilities. It has been specifically designed to sort data efficiently while offering the user great flexibility in designing sort programs. It is written in BASIC09* for use under OS9.

COMPOUNDING FUNCTION

SORTC has the capability of summing user-specified numeric fields on equality of keys. This allows significant savings in memory, disk space, and program development time. A reduction in the number of disk accesses required when compared to other sorts is inherent in the design of SORTC.

DISK BASED

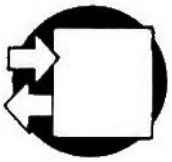
Specifically designed to sort large volumes of data, SORTC imposes no size restrictions on the amount of data to be sorted. It also places no limits on the number of sort keys which can be used or the order in which the keys are sorted. Furthermore, the sort procedure can be performed as many times as necessary within the same program. This feature allows the programmer to take advantage of any existing data bias, and possibly even reduce the size of the sort key.

ADVANCED DESIGN

While most disk sorts are partially based upon the Fibonacci series, SORTC is not. SORTC is a generation ahead of the normal sorts based upon the "Fib series". Its unique algorithm is automatically optimized at run time for a reduction in workspace, reduced # of disk accesses and shorter run times. Designed to be as "crash proof" as possible, the sort procedure will not abort if it is accidentally asked to sort zero items.

EASY TO USE

It is not difficult to design a program which will use JBM's SORTC. Since SORTC is a subroutine, the user may write any procedure he or she wants to format the data for sorting and then to process the sorted data. The sorted data need not be written back to disk, but instead is immediately available. The sort code is automatically inserted into the source procedure by a simple Sort Generator.



JBM'S MIDWARE

*OS9, BASIC09 are registered trademarks of Microware Corporation.

**Uses the same algorithm as JBM's SORTC for Digital Equipment Corp. RSTS Systems.

ORDERING INFORMATION

SORTC, from JBM's MIDWARE line of quality software, is available on either five and one-quarter or eight inch diskettes for a price of $150.00. All of JBM's software packages come complete with comprehensive user's manuals.

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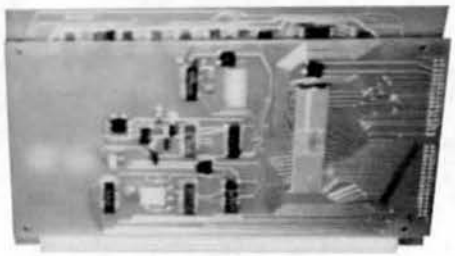

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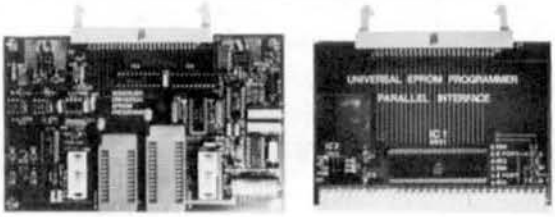

- PROGRAMS and VERIFIES 2508, 2708, 2516, 2716, 2532, 2732A, 2564, and 2764 EPROMS. Minor hardware mods are required to program the INTEL 27128.
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  b. READ an EPROM into the buffer.
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  f. FILL a selected area of the buffer with a specified character.
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- Well documented users manual provides step-by-step adaptation and operating instructions.

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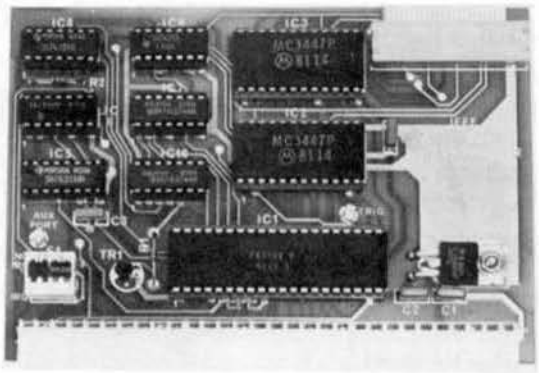
IEEE-488



- SUPPORTS ALL PRINCIPAL MODES OF THE IEEE-488 (1975/8) BUS SPECIFICATION:
  - Talker — Serial Poll — Single or Dual Primary Address
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  - System Controller — Group Trigger — Talk only...Listen only
- Fully documented with a complete reprint of the WILDBAUD article on the IEEE bus.
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PL/9

EDITOR/COMPILER/DE-BUGGER

- Friendly interactive environment where you have INSTANT access to the Editor, the Compiler, and the Trace-Debugger, which, amongst other things, can single step the the program a SOURCE line at a time. You also have direct access to any FLEX utility and your System Monitor.
- 250 page manual is organized as a tutorial with plenty of examples.
- Fast single pass compiler produces 8K of COMPACT and FAST 6809 machine code output per minute with no run-time overheads or license fees.
- Fully compatible with TSC text editor format disk files
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- Logical operators: (.AND), (.OR), (.EOR/.XOR).
- Control statements: IF..THEN..ELSE, IF..CASE1..CASE2..ELSE, BEGIN..END, WHILE.., REPEAT..UNTIL, REPEAT..FOREVER, CALL, JUMP, RETURN, BREAK, GOTO.
- Direct access to (ACCA), (ACCB), (ACCD), (CCR) and (XREG).
- FULLY supports the MC6809 SWI, SWI2, SWI3, NMI, FIRQ, IRQ and RESET vectors. Writing a self-starting (from power-up) program that uses ANY, or ALL, of the MC6809 interrupts is an absolute snap!
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A co-resident EDITOR/ASSEMBLER for the 6809 written by Graham Trott which takes most of the pain out of assembly language program development:

- Friendly interactive environment where you have INSTANT access to the Editor, the Assembler, FLEX and your System Monitor.
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- Includes XMACE a co-resident 6800/1/2/3/8 EDITOR/CROSS ASSEMBLER.

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This is the FLEX version of the James McCosh 'C' compiler that is also available on UNIFLEX from SWTP and OS-9 from Microware:

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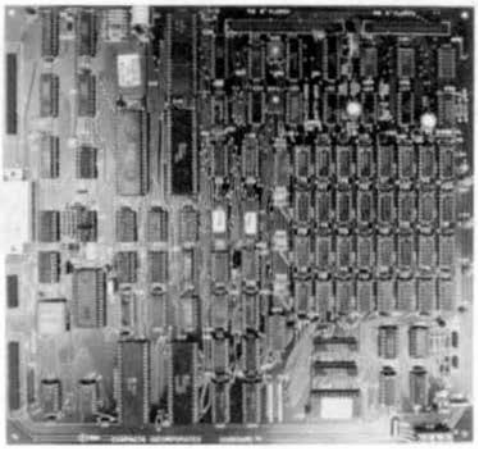

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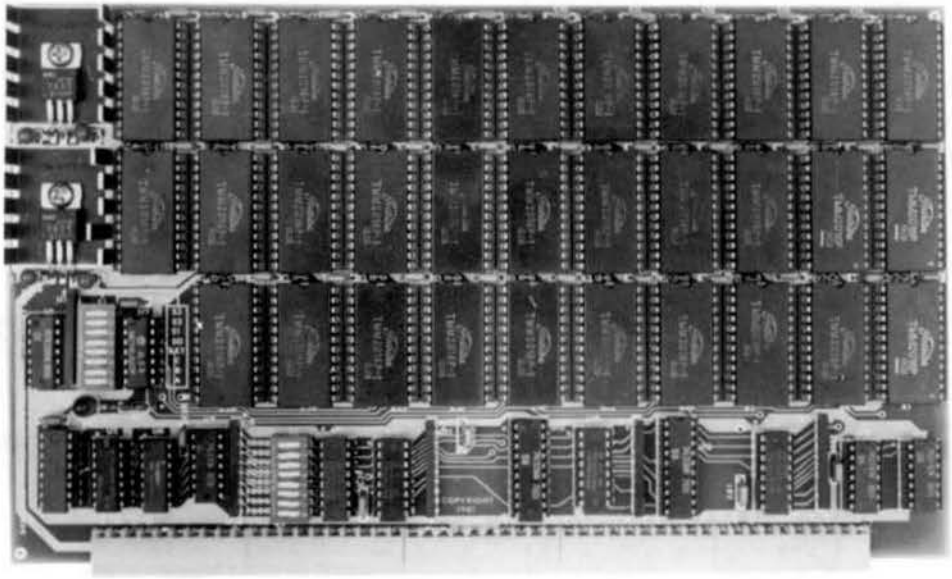

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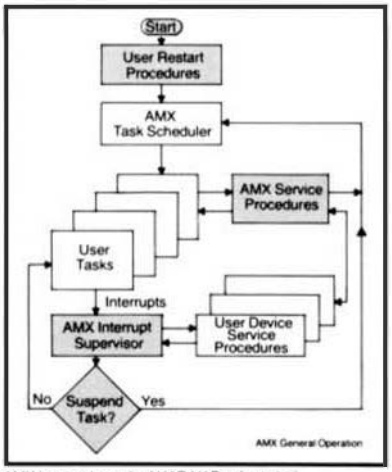

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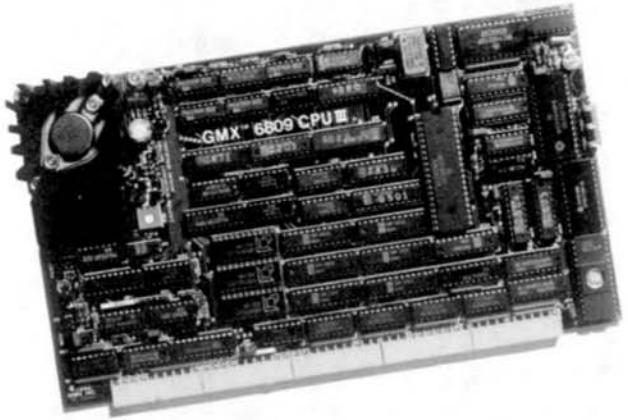

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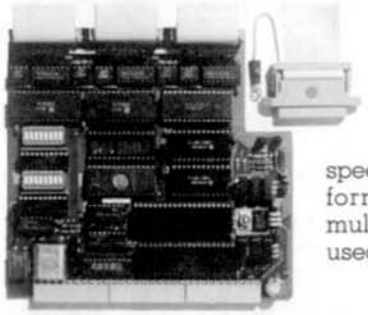

GIMIX 6809 systems support five predominant operating systems:

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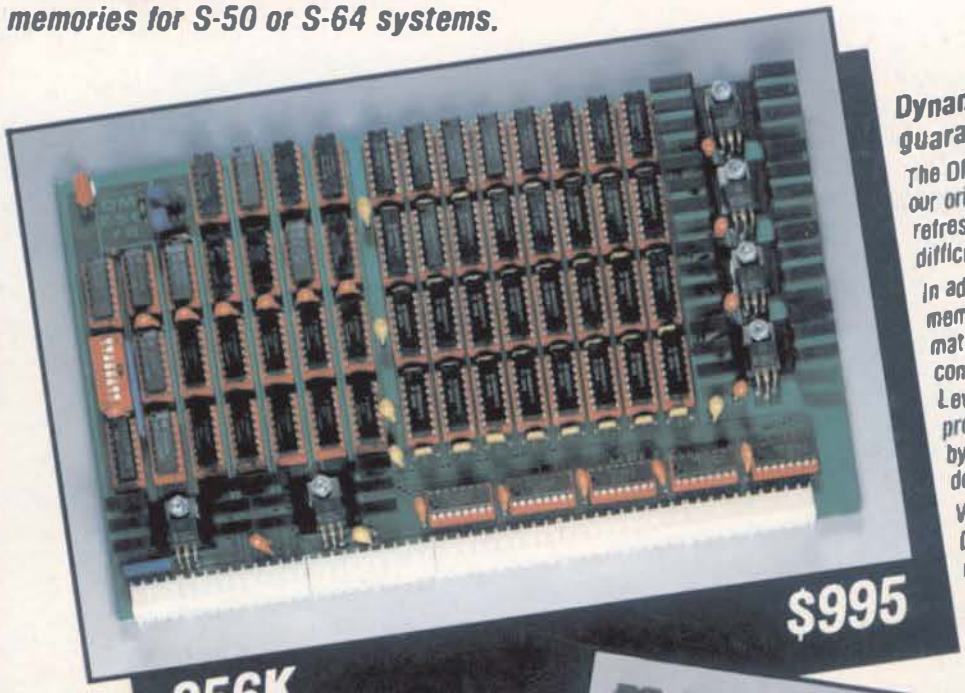

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